United States Circuit Court of Appeals

TENTH CIRCUIT.

No. 2550.

COLORADO INTERSTATE GAS COMPANY, a corporation, PETITIONER,

vs.

FEDERAL POWER COMMISSION; CITY AND COUNTY OF DENVER, COLORADO; PUBLIC SERVICE COMMISSION OF WYOMING; COLORADO-WYOMING GAS COMPANY; and CANADIAN RIVER GAS COMPANY, RESPONDENTS.

No. 2551.

CANADIAN RIVER GAS COMPANY, a corporation, PETITIONER,

vs.

FEDERAL POWER COMMISSION; CITY AND COUNTY OF DENVER, COLORADO; PUBLIC SERVICE COMMISSION OF WYOMING; COLORADO-WYOMING GAS COMPANY; PUBLIC SERVICE COMPANY OF COLORADO; and COLORADO INTERSTATE GAS COMPANY, RESPONDENTS.

ON PETITION TO REVIEW AND SET ASIDE ORDERS OF THE FEDERAL POWER COMMISSION.

FILED SEPTEMBER 9, 1942.

VOLUME 7—Pages 3671-4350

Witness HAMMER further testified on cross examination, Vol. 54, pp. 7507-7593, inclusive, as follows:

The pressure contour (Isobar Map 179) follows the outlines of the field, with some minor exceptions, as determined by the Texas Railroad Commission, the total distance from one end of the field to the other being approximately 120 miles. The outline of the field was not determined by the witness but he merely copied the outline as determined by the Texas Railroad Commission, with some minor exceptions.

Beginning at a point just southwest of the town of Pampa right near the southwestern limits of the town, a dotted line is shown which runs generally from that point to the northwest through the remaining portion of Gray County across Carson County and through the more or less central portion of Hutchinson County. This dotted line (Exhibit 179) represents the northeastern limits of the productive gas territory or the outer limits of the gas field in this particular area as interpreted by the Texas Railroad Commission.

The area between the dotted line above referred to, and the outer heavy solid line in the same area, represents oil producing territory. There are some dry spots but generally the structures are favorable for oil production. The little dots between the dotted line and the outer heavy line represent producing oil wells, each dot representing a well, but he did not know the approximate volume of oil production in the field as of the time of testifying.

There is another dotted line generally south and southwest of the dotted line above referred to on the pressure contour map (Exhibit 179). This dotted line begins just south of the town of Pampa in Gray County and runs generally from that point in a northwesterly direction in a rather irregular wavy line across the north portion of Gray County, entirely across Carson County and intersecting the Carson-Hutchinson county line some ten miles east of the northwest corner of Carson County. The line continues across the southwestern portion of Hutchinson County and intersects the Hutchinson-Moore County line at a point probably 12 miles north of the southwest corner of Hutchinson County. It continues across Moore County and northwesterly to a point some 6 or 7 miles east of the town of Dumas in Moore County, thence in a general southwesterly and

southerly direction across the town site of Dumas, thence a little to the southeast and then turning back again southwesterly to a point where it intersects the Moore County and Hartley County Line about 5 miles north of the southwest corner of Moore County; thence, a curved line from that point extending somewhat into Hartley County and then turning back southeasterly again and then generally in a southerly direction to a point of intersection with the southern limits of the field near the northwest corner of Potter County. This line represents the division point between the sour gas producing area and the sweet gas producing area.

Sour gas contains sulphur and/or hydrogen sulphide in quantities too great to make such gas desirable for domestic use, while sweet gas is comparatively free from such substances. Otherwise the two gases are practically the same.

The sweet-sour gas line was not located by the witness but was taken from maps prepared by the Texas Railroad Commission.

Sour gas is produced north and northeast of the line and sweet gas, south and southwest of the line, except at the western edge of the field where the sour gas is produced generally west of the line, and sweet gas east of the line.

Again referring to the little dots on the pressure contour map included in the gas producing area, beginning in Wheeler County near the south-central portion of the County and running pretty well along the northeastward portion of the gas field, across Wheeler, Gray and Carson Counties, and well into Hutchinson County, all of which are in the gas producing area, such dots generally represent oil wells, all of which have been drilled in the gas producing area and through the gas producing horizon before they encountered oil. This portion of the gas field also produces oil and has produced large volumes of oil. The structural conditions are such, however, that in drilling for oil they have drilled through gas-producing formations, the oil lying just ~~underneath~~ the gas, in a separate strata.

The discovery well in the entire panhandle field was drilled in about 1918 or 1919 on the Masterson Ranch in Potter County, and on acreage that the witness thinks is now owned by Canadian River Gas Company. This well,

the witness has been told, was just a wild-cat well. Other wells were drilled at a later date in Potter County. The nearest known production of oil or gas at the time this well was drilled was in the vicinity of Vernon, Texas, or somewhat east of Vernon, around Iowa Park, Texas, the distance being probably 200 miles from the Masterson Ranch well. After the Masterson well was drilled there were other wells drilled in an effort to find oil. There was a great deal of drilling but for the first several years after the discovery well the most of the wells drilled were gas wells, and although such wells were drilled for oil, the operators were successful only in developing gas.

The witness further testified (Vol. 54, p. 7524) as follows:

Q. Was there any market for the gas at that time, do you know, Mr. Hammer?

A. Well, there was a market but there wasn't any outlet.

Q. All right; we'll say that?

A. No, there wasn't any at that time.

The first oil well was drilled in the Texas Panhandle Field in about 1925, although oil might have been discovered somewhat earlier than that date. The big production of oil in the field began with the discovery of the Borger field in the latter part of 1925, or the first part of 1926. The presence of oil was probably known to some degree in the latter part of 1925, but the big drilling campaign commenced in 1926.

Borger is in the southern part of Hutchinson County. The various little dots shown on the isobar contour map (Exhibit 179) to the eastward and to the northeastward, to the north and to the northwest of Borger, might be termed the original Borger oil pool which became very active in 1926. All of the wells around Borger, between Borger and the dotted line which represents the outer limits of gas production, were drilled for oil, and generally all of them produced oil, but I think those wells were drilled through the gas producing formation. Very little attention was given to saving and utilizing gas production at that time. A great deal of gas was blown into the air. Later gasoline plants were erected and a small volume of natural gasoline was extracted from the natural gas and the residue was blown into the air. Residue gas is the gas that remains after the gasoline

has been extracted, and you have almost as great a volume of gas after the extraction of the gasoline as you had before. All of this residue gas was blown into the atmosphere.

Following the discovery of the Borger pool wells were drilled in and around that general area, the wells generally being southeastward from Borger along the northeastern portion of the structure, down to Pampa and the little town of Lefors in Gray County and on down into the northern portion of Wheeler County. Many of the wells, although drilled for oil, discovered gas only. If they were drilled a little too high on the structure to produce oil, they almost certainly encountered gas. A great many of the old gas wells that were drilled primarily for oil in the first instance were disappointments since no oil was discovered, but they did encounter gas and the wells were saved as gas wells.

Many of the oil wells produced both oil and gas. All of the little dots shown on the Map (Exhibit 179), but within the gas producing area, also encountered gas, or at least the greater majority of them did. There might be some exceptions to this but generally they all did discover gas. It is a very rare thing to get a dry hole within the gas producing area so far as gas in concerned. Each of the wells represented by the little dots above referred to encountered gas even though the wells might also have encountered oil, unless the well represented a dry hole in both cases.

There were a great many gasoline plants constructed in the early days of the Texas Panhandle Field to utilize gas for the manufacture of natural gasoline. During that period this field became noted as one of the largest natural gasoline producing areas in the world. Plants were constructed pretty well along the entire northeastward border of the field from Wheeler County to Hutchinson County and later on up into the northern portion of Moore County. The witness did not observe the practice of completing oil wells during that period, but did learn from his general investigation, and in discussing the matter with operators in the field, that well owners did sometimes cement the inner casing improperly, or after cementing it jar it loose or perforate it in some other way in order to get a much larger gas production from the gas producing strata above the oil strata. Witness stated that he had heard this practice be-

came the scandal of the industry for a while, and he had heard it said that there were great volumes of dry gas or natural gas produced with the innercasing string and then processed for its natural gasoline. The witness assumed that all of the gas in the Texas Panhandle Field, whether it is produced in the oil field section or high on the structure or wherever it is produced, does have sufficient gasoline content to make it profitable to remove the natural gasoline. It is a uniform practice at any rate to remove the natural gasoline from such gas, and if it were not profitable Canadian River would not be taking it out.

After the natural gasoline plants were constructed carbon black plants were constructed in the field to utilize the residue gas from the gasoline plants. The carbon black plants were generally constructed near the gasoline plants. Plants were constructed in the northern part of Parsons County around Whitedeer, around Pampa and in Wheeler County, in Moore County and around Borger. A great deal of the gas produced in the field was not utilized for fuel but was blown into the air or burned in carbon black plants. The witness does not know the total volume of gas used in the manufacture of carbon black but he would not be surprised if more than 90% of all of the carbon black in the world is made in the Texas Panhandle.

Carbon black is made simply by burning the gas against an iron. It is burned under low or insufficient air conditions so that it will produce what is ordinarily called a smoke or soot. The soot collects on the angle iron and a moving chain with scrapers removes it. Carbon black is just the soot from the burning of gas against a steel plate somewhat like the smoke off of a lamp chimney. It takes around 1,000 cu. ft. of gas to make a pound of carbon black. Carbon black is used largely in the production of automobile tires and prolongs the wear and tear on tires—it toughens the tire. Before the days of carbon black, zinc oxide was used for that purpose, but did not give nearly as much mileage on the tires as carbon black.

The next step in the evolution of the gas industry in the Texas Panhandle Field was the construction of stripping plants. This period began along in 1933 or 1934, after the Legislature of Texas had enacted a statute which permitted operators to utilize gas from gas wells, that is, just natural

gas as produced from the wells and extracted the gasoline from the gas and vent the residue into the air. The witness recalls that there were several such plants constructed and great volumes of gas during that period were popped (vented) into the air.

Still later the Legislature of Texas enacted a statute permitting the manufacture of carbon black from sour gas. The carbon black industry was greatly expanded subsequent to that time although there had been carbon black plants in the field prior to that time utilizing the so-called casing head gas, that is, gas produced with the inner string of casing, but which frequently, by reason of improper well completions, came from the gas producing stratum above, that is, from the gas producing portion of the structure.

Sour gas is produced north and northeast and in the western part of the field to the west of the sour gas line hereinabove referred to, and the wells located in that portion of the field produce sour gas. This gas is run into gasoline plants and the residue is burned as carbon black.

The witness has not particularly traced the history of the carbon black plants, and in getting his production figures did not attempt to determine the volume that was consumed by carbon black plants. He attempted to go back of 1935 in his production studies, but decided that the data prior to 1935 was not complete although the Texas Railroad Commission had compiled production figures prior to that date, but the gas was reported on different pressure bases.

The witness further testified as follows (Vol. 54, pp. 7555-7561):

Q. We are just about through, Mr. Hammer, with some of this historical background. I believe we were on the matter of the legislation of the State of Texas which permitted the use of certain types of gas for carbon black, were we not, when the recess occurred?

A. Yes, I think we were.

Q. Now, your study of the history of the field and particularly the production history of the field, has indicated to you just what has happened since that legislation was passed, has it not, Mr. Hammer?

A. When was the legislation passed?

Q. It was passed in 1935.

A. That is the statute you are talking about, the 1935 statute?

Q. Yes. It is ordinarily referred to as "House Bill 266," almost universally so. You will see in the Railroad Commission's report that it is listed as "House Bill 266."

A. I think in general that my study has covered that period from 1935 on.

Q. Now, prior to that time you had noted no doubt that the gas that was utilized by carbon black plants was produced generally in the Borger area and I might say also in the Sanford area just west of Borger. Do you know what I mean by the Sanford area?

A. As I stated a while ago, I haven't traced the history of where carbon black plants were located.

Q. In getting your production figures which show the outlet for the gas or the disposition of the gas, it shows certain portions of the gas for carbon black plants, doesn't it?

A. You are referring to the time prior to 1935?

Q. Yes, from the beginning to almost 1939.

A. Well, from 1935 on we took notice of that phase of it, yes.

Q. Well, didn't you go back of 1935 at all in your production studies?

A. Yes, we attempted to go back of 1935 but if you will recall in my written statement—I said that just because of this thing we are talking about now—that I didn't consider the data prior to the time of such characterization that it could be utilized with any degree of accuracy.

Q. But you necessarily had to go back of that before you could determine that in your mind it was not satisfactory for your use?

A. I did go back of that.

Q. So you had to go back of 1935 in your study of the field and the producing history of the field?

A. That was after I had found out that the history was up to a certain point prior to 1935 and then decided to make my study on the area from 1935—at times from 1935 on, I did not give that early period very much attention.

Q. What was the difficulty, Mr. Hammer, with those earlier records which you discarded in your study of the matter?

A. Well, I think I have stated that fairly well in my written statement.

Q. You said it was black-out. It wasn't hardly that bad?

A. All right.

Q. The Railroad Commission of Texas has compiled—

A. We couldn't depend upon the early pressure that was recorded. The various bases at which gas was reported to the Texas Railroad Commission varied over such a wide range, and as a matter of fact, the Texas Railroad Commission itself has no information that can be relied upon as to what pressure was utilized in those early reports turned into the Commission.

Q. That is quite true. I say, that is quite true, but I don't know whether I mean to say just that, but I do mean to say that the Commission prior to 1935 did not require gas to be reported on a uniform pressure basis?

A. That is right.

Q. And that is as far as that statement can go, isn't it? They did require the reports?

A. They did require the reports.

Q. The production reports?

A. The production reports, but they didn't—

Q. Some operator might operate on some pressure that was one and some other—

A. That is right.

Q. And that is the extent of your criticism, isn't it?

A. That is one of them.

Mr. March: Please let the witness finish, Mr. Keffer.

Mr. Keffer: I beg your pardon. I thought he had.

The Witness: I made an attempt to get at the early history of those early pressures—those early pressure bases, and I wasn't very successful.

By Mr. Keffer:

Q. As a matter of fact, the Railroad Commission of Texas does carry in its records the annual volumes of gas production in the Panhandle and as the official regulatory body of the state of Texas does rely upon those records, is that not a fair statement?

A. Well, there are various degrees—

Mr. March: We object to the question. We don't object to the rewording of the question, but to have this witness to say what the Railroad Commission of Texas relies upon,

Mr. Examiner, isn't a proper question. He can reframe the question.

Mr. Keffer: Suppose you ask the question.

Mr. March: I am not interested in getting an answer but I am interested in seeing that this witness is not put in the position of testifying as to what the Railroad Commission of Texas relies upon.

By Mr. Keffer:

Q. You can say if you don't know, Mr. Hammer.
You went through the Railroad Commission's records at Austin, Texas, did you not?
A. That is right.
Q. And you got certain data from those records?
A. That is right.
Q. And so far as you know, the Railroad Commission does rely upon the records which they keep and have in their possession with respect to this gas production?

Mr. March: I object—

Mr. Keffer: I said, as far as he knows.

Mr. March: As far as the Commission's counsel is concerned he is not going to permit the witness to answer unless the Examiner so rules, because any construction this witness can put on what the Railroad Commission relies upon or any Commission relies upon is a construction or question that can be answered either way by the witness. He shouldn't be required to answer it. He could say he didn't know, of course, but it is an improper question and we don't propose to stand idly by and see an improper question answered.

Mr. Lange: Too, Mr. Examiner, even if he stated he knew or thought he knew, he couldn't read the minds of the Texas Railroad Commission to determine what they had in mind.

The Trial Examiner: I think that is right, Mr. Lange.

When you use the term "rely," Mr. Keffer, by that you mean that is the only official record, the official record that the Railroad Commission has of the production in the field?

Mr. Keffer: That is exactly what I mean, that the Railroad Commission's orders are of course official records, it being an official body.

Mr. March: He can ask whether he knows as to those records being on file with the Railroad Commission of Texas. He can ask that question and he can state whether they are filed, but to say as to whether this Commission relies upon those records generally or in any specific case, that is a matter not for this witness to testify to.

Mr. Keffer: It doesn't make any difference in particular.

I believe, Mr. Examiner, that they do rely upon those records.

The Trial Examiner: I would think so, Mr. Keffer, assuming they are the only records they have. However, I think the argument of Commission's counsel is sound.

Mr. Keffer: I think that is probably correct.

Q. I might have asked you the question, but to be certain, I will state it again anyway.

The Railroad Commission of Texas does keep records prior or does have records showing the production of gas from the Panhandle field prior to 1935?

A. Yes, they do. I might add to that that we found in the Commission's early records in Austin, Texas; that they were very incomplete; that there were a lot of people in the early days who produced gas but didn't turn in any reports.

Q. You have no idea as to the relationship or as to the percentage, rather, of reported gas and unreported gas?

A. No.

The witness made no distinction between sour gas production and sweet gas production in his studies and made no segregation as between carbon black plants or other uses, although he did consider the total volume of production from 1935 to 1939 without regard to the uses of the gas produced. He was not interested in the segregation of the figures after the gas came out of the ground. He gave no consideration to the volume of sweet gas that was produced because, according to his viewpoint, he didn't think in terms of sweet or sour gas, but he was interested in getting the volume of gas that came out of the ground. Although he spent some time in the field he did not inspect any of the carbon black plants. He saw them but he didn't pay any particular attention to them. It didn't make any difference

to him what became of the gas after it was produced and it didn't require any knowledge of the carbon black plants or their locations, or the volumes consumed by them. He didn't use judgment factors to any great extent, but his work was based as nearly as it could be on the actual factual data. There might be some slight variation from this, but not very much. He used his judgment to some extent, but not a great deal. The only factor he needed was the volume of gas that came out of the ground and the disposition of it made no difference, or whether it was sweet or sour gas, or whether it came from the sweet gas area or the sour gas area.

In every one of the areas (quadrants) the witness considered all of the gas that came out of all of the wells and every quadrant in the field as nearly as he could get it, and then utilized that information in that particular area regardless of any disposition of gas after it was metered from the well. He stated, for example, that when he considered the reserve estimate of quadrant 2 in Hutchinson County, which includes Borger, he was not particularly interested with the gas that came from east of Borger where so many wells have been drilled, or whether it came from the southwestern portion of the quadrant, or whether it came from the northern part of the quadrant. It made no difference whatsoever in so far as the witness was concerned.

Witness knew there had been an increase in gas production in Moore County since 1935, but he didn't know whether there was a slight increase or a large increase until he had a chance to check it. He didn't think there was any production, relatively speaking, in the sour gas area of Moore County prior to 1935. He knew there had been a large production of sour gas in Moore County beginning with 1936, but didn't know the volume and didn't know whether it produces more than one-half of the sour gas in the entire field or not. He did not know from memory how many carbon black plants there were in Moore County, and neither did he know the number of casinghead plants—natural gasoline plants—without checking. He did not know whether there were any pipe lines leading out of northern Moore County to the Borger and Sanford area in Hutchinson County which transported sour gas to carbon black plants, but thought there was one line that transported sour gas to gasoline plants.

The natural gas development in the Panhandle, with respect to pipe lines, began in about 1928. The pipe lines take their gas from sweet gas lines, and practically speaking, there is no sour gas used in the pipe lines except for a small portion in Hartley County, and perhaps isolated cases over the field along the sour-sweet gas line. The pipe line companies are taking sweet gas almost exclusively from the sweet gas area.

The witness did not know the comparative volume of gas produced from the field that actually goes into the pipe line leading out of the field as compared to the total production of the field. He made no study of that at all. The witness paid no attention whatsoever to gas that was lost in drilling operations because it was virtually impossible to get it and he would have to rely on somebody's judgment since such gas was not metered.

The witness went into the field a number of times and discussed all sorts of matters with various field superintendents, and in many cases the opinions were checked against the records but he couldn't, at the time of testifying, be more specific as to just what information he gained from them. The witness then stated that it was very difficult to make an estimate of gas reserves in the Texas Panhandle Field, or in any other field, without having a rather intimate knowledge of the field, and that it takes time to do this and that you get part of the information from the people that live and work in the field, and the rest of it is personal observations made by going through the field.

The witness further testified (Vol. 54, pp. 7586-7591) as follows:

Q. Just how many trips did you make through the field, Mr. Hammer, approximately? Give it to me approximately, if you haven't it exactly.

A. I don't know as I could give you that exactly. Oh, it was probably ten or fifteen, something like that.

Q. What did you do when you would go out on these trips?

A. We would try to find, usually, the field superintendent of these various companies producing gas.

Q. What would you do when you found him?

A. We would ask him all sorts of questions trying to get

facts and opinions from people that we thought should have a worth-while opinion.

Q. Did you then check those opinions against records?

A. In most instances we checked a lot of those opinions, yes.

Q. What was the occasion of having these opinions if by scientific process you can take a slide rule and figure it all out?

A. Well, I will change that. I will say experience of these superintendents.

Q. What do you mean by experience? What does that include?

A. Well, that includes their operating experience in the production and drilling and care of gas wells, things of that type.

Q. That is still rather general. Can you be more specific on just what information you gained from them?

A. Not right at the present time.

Q. You knew at the time how gas wells are operated, pretty well, didn't you?

A. Well, various superintendents had various ideas of how to do this thing and how to do the other thing. They don't all have the same ideas, and what we were after was—

Q. Did that help you, then, to formulate an opinion as to the reserves in the field after talking to those people?

A. It helped to give us certain facts or where we could find certain facts.

Q. In other words, to get back to this fundamental thing, it is difficult to make an estimate of gas reserves in this field or any other field without having a rather intimate knowledge of the field, is that not correct?

A. You must get a rather intimate knowledge.

Q. It takes time to do that—you get that from the people that live in the field and work there. Is that a fair statement?

A. Well, that's part of it.

Q. What's the rest of it?

A. Well, the rest of it is observation personally that I got from the field in going through it.

Q. That's right. I appreciate that, that you do get knowledge that way that is of substantial benefit in the kind of work in which you were engaged, but now can you detail

just a little more the observations that you did make in that connection?

A. Well, I'll tell you the particular thing, among other things, the particular thing we wanted to find out in talking particularly to the superintendents was such things as the condition of the wells, where the condition of wells had any effect on the pressure and volumes of the wells, or whether there were any water effect in the well in different localities; whether wells had been drilled too deep, for example, and had gone into water, and where they had drilled down into the granite wash, and what the effects of these things of that kind were.

Q. Now, did you ask them about the actual drilling of the wells, the type of formations encountered and matters of that sort; where they encountered them?

A. Oh, we discussed that, I think as a sort of a side issue because we had most of the logs on the wells.

Q. You relied on the logs very largely to give you that type of information?

A. Yes. There were too many wells to do anything else with.

Q. As to the development and as to producing formation and so on?

A. Well, we discussed the reservoir conditions with some of them, certainly, because that was a problem.

Q. Did you examine any well cuttings?

A. It wouldn't have done me any good if I had.

Q. Why?

Mr. Spencer: The question was, "did you?"

The Witness: No, I didn't, and I repeat again it wouldn't have done me any good if I had.

By Mr. Keffer:

Q. Wouldn't have meant any more to you than if I had gone out and done that?

A. That's right, or anyone else, for that matter.

Mr. Keffer: Mr. Examiner, it is a little past 4:30 and it might save a little time if I could get some of the rest of my examination a little better in mind.

If the Examiner would like for me to blunder on through, I can, but I think—

The Trial Examiner: Well, I don't want to force you to go ahead, Mr. Keffer, if you feel—

Mr. Keffer: I feel it would be advantageous to me, but certainly to the Examiner, and I think maybe to the attorneys and maybe even to the witness.

The Witness: May I make a statement?

Mr. Keffer: Yes.

The Witness: I said I hadn't examined any of them. I want to qualify that this way.

Mr. Spencer: Any what?

The Witness: Any of the nut cuttings. I didn't examine any cuttings but I did examine a considerable number of cores that were taken from the field, that were taken out in the early days before they started using cable tools for finishing the well.

By Mr. Keffer:

Q. Did you examine any late cores?

A. I don't think they have taken any recently.

Mr. March: Mr. Hammer, you went through the field just for your general information?

The Witness: That is right.

Mr. March: You didn't collect this basic data for this exhibit by going around talking to somebody and considering what he said the cuttings were, and so forth, or hearsay like that?

The Witness: I paid no attention to anything like that.

Mr. Keffer: I want to interpose an objection to counsel leading his witness, and I think that objection has good foundation.

Mr. Hammer continued his testimony as shown by Vol. 55, pp. 7598-7782, inclusive, as follows:

Q. Mr. Hammer, did you make an effort to secure information that Mr. Keffer requested regarding the utilization of gas for carbon black purposes?

A. Yes, I did.

Q. With what result? Were you able to secure the yearly production?

A. The annual reports of the Texas Railroad Commission give that information by daily averages by months. I found in none of them a total figure, and in each year, of course, the only report was for the first seven months of the year, so that in order to get a total for the year, taking daily averages by months, it would require an enormous amount of work.

Now, in lieu of that, I got some information that I think will fill the requirement and give what counsel wants as well as giving the total figures.

Q. Will you read that into the record?

A. These excerpts that I will read are verbatim quotations from the actual report of the Texas Railroad Commission for the years 1938 and 1939.

The first quotation is on Page 18 of the 1938 Commission report: "Of the total gas produced in the field and utilized during the first seven months of this year, 37.4 per cent was taken by pipe lines for light and fuel distribution; 45 per cent was burned in carbon black plants * * * "

Cross Examination

By Mr. Keffer:

Q. How much?

A. 45 per cent.

" * * * 2.3 per cent was vented into the air from gasoline plants; 11.6 per cent was consumed as plant and lease fuel and 3.7 per cent was accounted for as extraction loss in the removal of gasoline content."

That is for 1938.

Q. That is for the first seven months in 1938?

A. In the first seven months.

In 1939—the first quotation is on Page 9 of the 1939 Texas Railroad Commission's report: "Casing head production continued its decline, falling about fifteen billion feet for the year, or approximately 12½ per cent. The amount of sour gas withdrawn decreased roughly sixteen billion feet from the last year's total."

On Page 11 of the 1939 annual report—

Q. Was that 1937 or 1939 you have just been reading from?

A. 1939.

Q. 1939?

A. Yes. "The total gas produced in the field and utilized during the first seven months of this year, 40.31 per cent was taken by pipe lines for light and fuel distribution; 45.76 was burned in carbon black plants; 1.55 per cent was vented into the air from gasoline plants; 8.92 per cent was consumed at the plant as lease fuel and 3.46 per cent was accounted for as extraction loss through the removal of gasoline content."

Mr. March: Mr. Hammer, did you utilize any of that data in the preparation of this exhibit?

The Witness: No, I did not.

Mr. March: I wish to state we are furnishing this information because we want to cooperate with you, Mr. Keffer, but this has nothing whatsoever to do with the exhibit and if you want any further information regarding the disposition of the gas produced in the field, you will have to put it in by one of your own witnesses. I want to get the record clear in that regard.

The witness made no use of this data in the preparation of his Exhibits 179 and 180. He considered the geology of the field only in a general way. His study of the character of the field dealt largely with the characteristics of the producing horizon itself. The producing formations are dolomites and limestones, but the greater part of the producing formations are dolomites. There is some granite wash, but it has relatively little importance, and it is his opinion that it would be better practice not to even try to recover the gas in the granite wash until the field is more nearly exhausted from the upper horizon. The most prolific gas producing areas in the field are in part of Carson County and the northwest part of Moore County which follow a line close to the axis of the fold, and he means by "axis" the highest structural point which would be somewhat south of the exact center of the field.

The witness further testified (Vol. 55, pp. 7605-7606) as follows:

Q. What do you mean "axis"?

A. The highest structural point.

Q. In order that we might visualize that a little greater, would you say that the axis, generally speaking, would represent a line just about dividing the field into two equal parts?

A. No.

Q. Give me a little more definite description of what you mean by axis.

A. It would be somewhat south of the exact center. It is difficult to describe it.

Q. I appreciate that. I would like to have you just as nearly as you can give a general statement that the Examiner and others here might hear in order that they might visualize pretty well what you mean by that.

A. Well, in general—this is just a broad explanation—

Q. I understand that.

A. The axis of the fold would start in some place in the vicinity of Quadrant 3, Moore County; it would cut across Quadrant 2, and the southwest corner of Quadrant 1, Moore County; the northeast corner of Quadrant 1, Potter County; and through about the center part of Quadrants 3 and 4, Carson County; and just north of the town of Whitedeer, or in the vicinity of Whitedeer—

Mr. Lange: What county?

The Witness: Carson County.

Then it would hit into Quadrant 4 of Gray County; thence from there in a southeast direction through Quadrant 5, Gray County; Quadran 4, Gray County; Quadrant 3 in Wheeler County, and Quadrant 2 and 1 in Wheeler County.

Mr. Lange: That is Quadrant 6, Gray County?

The Witness: That is right.

By Mr. Keffer:

Q. To state it a little differently, that is generally a line a little south of what you might call the center line from the northwest to the southeast?

A. In the western part of the field it would be considered south.

He determined that these areas were the most prolific by taking the total production for each quadrant and determining the per-acre pound decline. He examined some 700 or 800 gas well logs, but could not name them, did not keep a list of them, and did not record the data. He examined the well logs to see if the dolomite had been penetrated and to determine the physical condition of the well, but made no notes. He determined the total thickness of pay formation by taking the entire measurement of the dolomite penetrated whether it was productive of gas or not. He determined areas of low productivity and determined where the low production per-acre pound decline was located.

The witness stated that beginning with the bulging point on the south side of the field just south of Whitedeer in Carson County and east of this over into Gray County, and on through over to the eastern end of the field, you will find an area of low productivity and has no particular significance with respect to the producing ability of the field. It is an area of low productivity. He has determined that this is an area of low productivity by a study of the acre-pound decline. There has been quite a lot of production from the area just referred to in Wheeler County. The pressures in much of the area are high—above 420 pounds. The production has been slack. He found the productivity of the area along the limits of production, along the south side and southwest side of the field, to be variable in Potter and Carson Counties. Although his quadrant took in this acreage with other more productive acreage, it does not clearly show the extent of the productivity along the edges. He did not study the edges of the field particularly as to productivity in Carson and Potter Counties except as to the extent reflected by his quadrant as a whole.

In determining his weighted average pressures as a basis for his reserve estimates, he procured the weighted pressures from the weighted average areal pressure although he did not compute the acre content for the area between each isobar line, but only considered this area in determining his average pressures, then considered the entire acreage and the entire production in a quadrant in arriving at the per-acre pound decline in pressure. In other words, he first laid off the isobars, then laid out quadrants. He used a plani-

meter and determined the area in each quadrant between each isobar line. He then determined the area for the entire quadrant. He then took the area between the isobars and multiplied that by the average pressure between the isobars. Then he took the summation of all these and divided that by the total acreage and arrived at an average weighted pressure for the quadrant. This was illustrated by taking Quadrant 1 in Potter County. The isobar lines on the south line of the Quadrant indicated a pressure of 430 pounds. He had the pressure and the acreage in the 430 pound pressure segment and the production, but he did not attempt to determine the productivity between the isobar lines. He simply determined the weighted pressure and the weighted productivity for the entire quadrant. He made no effort to determine production or productivity segment by segment because it wasn't necessary in his opinion. He did not think he would have gotten any better answers if he had determined the volume of gas in place per acre between each isobar line and didn't know whether the Texas Railroad Commission approached the problem this way or not because they have never put out any estimate of reserves.

He then stated, with respect to the illustrative Quadrant, that he averaged the whole thing in from the north line of the county to the southern limits of production (Quadrant 1, Potter County). He didn't figure each segment separately, and that was true of each segment and of every Quadrant through out the field.

The witness further testified (Vol. 55, pp. 7631-7636) as follows:

Q. I take it from the statements you have just made in answer to preceding questions, Mr. Hammer, that you found no wells in the field that contained 200 feet of dolomite which produced gas all the way through the entire thickness of the dolomitic formation encountered?

A. Well, I understand your question now. I didn't before. I think it is a true statement that at least the logs don't show production all the way through.

Q. Do you have any better evidence than the logs on those things?

A. No.

Q. That's right. So, so far as you know there are none?

A. Are none what?

Q. Are no wells with 200 feet of producing thickness of dolomite.

A. As far as I know I would say there were none.

Q. That's right, and you have no reason to suspect that there are some with that much producing thickness?

A. Well, I think it would be a fair statement, although I think there is some confusion in the interpretation of a lot of things in connection with those wells in this respect:

You will notice on a log that it says an increase at such and such a point on the log—an increasing flow. As a matter of fact, it is difficult to tell exactly when an increase does start when you are drilling a well. You might have a slight increase in drilling down and suppose you only attempted to gauge an open flow well, say, every ten, fifteen or twenty feet in drilling. Well, you might have a slight increase all the way down, then when you gauged you might show a total increase. Well, if the formation happened to soften up a little bit right at the time you made your test you wouldn't be justified in saying that all that gas came out of that particular point, see?—because some of it might have come from above. There is more or less porosity throughout the entire thickness of the dolomite and naturally even the smaller—the parts of smaller porosity naturally contain some gas.

Q. All right, now, what investigation have you made to determine all those things you have been talking about?

A. I didn't make any investigation of porosity.

Q. You are just theorizing now?

A. No, it is based on knowledge after having been around dolomitic and limestone oil and gas fields for many years. That is a judgment.

Q. That is one thing you can't work out on a slide rule?

A. That is right.

Mr. March: May I interpose a question?

Mr. Keffer: Please answer the question first.

The Witness: Didn't I answer it?

The Trial Examiner: There is no question pending, Mr. Keffer.

Mr. Keffer: Go ahead, Mr. March.

Mr. March: You did not—

Mr. Keffer: Don't ask a leading question.

Mr. March: Maybe it will be best that I not ask a question. I will wait until redirect and take up the points.

Mr. Keffer: All right.

Mr. March: I didn't intend to ask a leading question.

The Trial Examiner: Were you going to clear up an uncertain point here in this testimony?

Mr. March: That's right. If this is not satisfactory, we can strike it, Mr. Keffer.

Mr. Hammer, when you were giving that average of 200 feet a few minutes ago, you did not intend—you were merely giving the average depth of the dolomite, were you not? You were not giving the average depth of the producing formation?

The Witness: That's right, the overall figures of the total thickness of the dolomite.

Mr. March: Did you use in any manner in this exhibit the thickness of the dolomite in the producing formations?

The Witness: No.

Mr. March: In the computation of your reserves by the pressure decline method?

The Witness: I did not use them at all.

Mr. March: That's all.

By Mr. Keffer:

Q. All right, now, as a matter of fact, Mr. Hammer, it all resolves itself into just this, doesn't it, that you weren't particularly interested with the thickness of producing formations; therefore, you made no specific effect to determine the producing thickness of producing formations?

A. Now, I will qualify that.

Q. Can you answer yes or no?

A. I can't answer yes or no and I won't answer it yes or no. I will answer it in my own way.

The Trial Examiner: Answer it, Mr. Hammer. You don't have to answer yes or no. You can answer in your own way, but try and respond to the question.

The Witness: What is the question?

(The question referred to was read by the reporter, as set forth above.)

The Witness: All right, I'll answer it this way: As I stated before, the only thing I was interested in was total penetration of the producing dolomite regardless of the so-called thickness of pay strings. I wanted the total penetration to find out—

By Mr. Keffer:

Q. You wanted the total penetration to see whether the open flow of the well was truly reflected, is that correct?

A. I wanted to see whether all of the thickness that could possibly produce gas had been penetrated.

Q. That's right, in order that you might know that there weren't some producing formations that were left that were not uncovered?

A. That is correct.

Q. All right, then, from the standpoint of making your reserve estimate, you cared nothing about the producing thickness in so far as reserve figures were concerned and paid no attention to them?

A. Well, now, let me get this straight: What do you mean by "producing thickness"?

Q. The actual number of feet that actually produced gas in any given well.

A. I maintain there is nobody that can determine that.

Q. Suppose there are people that say they can determine it?

A. All right, let them prove it.

Q. You aren't in position to prove it?

A. It is not necessary to attempt it.

Q. I know, but, now, if you will bear this in mind, Mr. Hammer, it will help this a lot. You have some rather definite ideas and you are pretty steadfast, apparently, on them. There may be other geologists that have other different ideas.

A. All right.

Q. We want to explore this thing fairly, fully and accurately. When I ask you a question, when you don't think it makes any difference, I wish you would answer the question anyway and we will get along a lot faster. Will you make that agreement with me on that?

A. Well, as far as possible.

The witness saw various wells drilled in between the years 1926, 1927 and 1928 when he was in the field, although he had not seen any drilled in recently, but he knew how they acted and how they looked when they were drilled in. He thought it was a very foolish requirement for the operating companies to require their geologists to observe wells drilled in. Although it is customary for companies to require their geologists to be present on the derrick floor when a well is being drilled through the producing formations, he still thinks this is a foolish requirement because he can get all that information from the well log of the average well and there would be no reason for being present. He does not believe that you can get an accurate determination of the porosity by examining well cuttings from gas wells in the Panhandle Field, or any where else, and he did not attempt to do it.

The witness further testified as follows (Vol. 55, pp. 7639-7644):

Q. All right, now, Mr. Hammer, again, have you ever known—I will state it that way—of gas reserves having been estimated by the porosity sand thickness method?

A. Yes, I have known of it.

Q. Do you think those estimates are of any value?

A. It all depends on conditions under which the estimates are made and the character of the producing horizon.

Q. Now, what are those conditions?

A. Well, you take sandstone condition, where your sandstone has not undergone any change, where it is not attacked by weak acids that might be in any gas or water, and if you have good cores, taken by the core barrel from the sandstone, you can arrive at a very definite—I think at least a fair estimate of gas reserves.

Q. Isn't it difficult to get good cores in a gas well?

A. It is almost impossible.

Q. That's right, so that you just take the whole thing out when you base it on good cores, don't you?

A. Yes. You mean as far as a dolomite—as far as the Panhandle is concerned?

Q. As far as any field is concerned.

A. If you can't get good cores?

Q. Yes, that's right.

A. I think that is in general a fair statement, if you want to get an accurate estimate.

Q. Well, we will just agree that you can't get good cores, generally speaking, in a gas producing formation.

A. In the Panhandle?

Q. Or anywhere else.

A. Oh, yes.

Q. Well, where do you get them?

A. Where?

Q. Yes.

The Trial Examiner: You mean what other field, Mr. Keffer?

Mr. Keffer: Yes, that's right.

The Witness: Well, I don't recall exactly now. I know of gas producing horizons where cores have been taken in the gas producing horizon.

By Mr. Keffer:

Q. What is the real reason why you can't get, ordinarily, a good core in gas producing formations?

Mr. Lange: You mean in the Panhandle?

Mr. Keffer: Anywhere.

Mr. Lange: Anywhere?

By Mr. Keffer:

Q. We'll say in the Panhandle. Maybe I should restrict it to that.

A. Yes, I don't like to—this is our problem right here.

Q. All right.

A. The reason is that—now, the question is, what are the reasons why you can't get a good core, is that right?

Q. That is right.

Mr. Lange: In the Panhandle.

The Witness: In the Panhandle.

By Mr. Keffer:

Q. That's right.

A. Well, apparently, the reasons are—I will qualify that somewhat. I mean that you can't get a good core through that part of the producing dolomite where it is indicated that a major flow of gas or oil comes from. You can get fairly good cores of some of the rest of the dolomite.

Q. That's right, but why is it you can't get a good core where the gas comes from the major flow?

A. Because the formation there is so soft and it has undergone perhaps so much solution in the past and attacked by different weak acids of different kinds. The only thing left perhaps is largely siliceous material that wouldn't be attacked by circulating waters or by weak acids, and when you attempt to get your core out all breaks down and goes all to pieces. You just can't get one out.

Q. Isn't that due primarily to the pressure of the gas?

A. No, I wouldn't say so because where you take a core with a rotary core barrel, the pressure exerted on that is by your fluid column; that is, by your mud column, tends almost entirely, if not entirely, to equalize your gas pressure so that it is just a question of the character of the material itself, is the reason why you can't get it out.

Q. Now, where you can't get good cores, what is the customary way for the determination of porosity?

A. I have never attempted to do it. I don't know.

Q. Do you know of any people that have attempted to do it?

A. I have heard of people that have, yes.

Q. How did they do it?

A. I don't know how they did it.

Q. As a matter of fact, can't you take your drill cuttings and examine them under a microscope and compare them with others of known porosity and by comparison arrive at a pretty accurate figure?

A. No, I don't think so.

Q. A lot of people do think they can.

A. Well, let them prove it.

Q. Well, now, as a matter of proving, you haven't proven

that it is not correct. Let's don't get into any argument about it.

A. Let me put it this way: I have yet to see any authority or any statement in any written literature where anybody has ever determined a method of determining the porosity of a dolomite or a limestone in place by the examination of the cuttings from that well.

Mr. Lange: In the Texas Panhandle field?

The Witness: Or any place else.

By Mr. Keffer:

Q. My question was, by comparing with certain cuttings of a similar formation concerning which the porosity is definitely known.

A. I don't think—

Q. Did you ever hear that?

A. I don't think it can be done.

Q. At least you are of the opinion that you can't do it?

A. I don't believe anyone else can.

Q. Well, now, you stated a while ago, I take it, that you can't utilize the porosity sand thickness method of determination of reserves in place in natural gas fields unless you have good cores of the area, is that right?

A. I think in general that would be—would approach, at least, a fair statement.

Q. You say "it would approach it." What is wrong with it?

A. Because of the horizontal variability in the dolomite itself. It varies so much from point to point that in order to get a fair average of porosity, even if you could take cores, you would have to drill more wells than would be ever economically or feasibly possible to drill in order to get a proper average.

Q. What is the variability in the Panhandle? You have referred to that two or three times.

A. Well, that's just the point. There are indicated variables there, but I don't know as anybody ever has been able to prove just what those variabilities are except in a general way. In other words, they are relative. They are a relative differential, not an actual.

Q. Don't you find that areas are rather uniform; that

the variability is between areas rather than between locations, from well to well?

A. No that rule won't hold.

The witness further testified as follows (Vol. 55, pp. 7646-7667):

Mr. March: Before we proceed further I wish to state I have secured the estimated reserves of the whole Texas Panhandle field and I wish to have it marked for identification.

The Trial Examiner: ~~Very~~ well.

Redirect Examination.

By Mr. March:

Q. I hand you what purports to be the remaining gas reserve in the Texas Panhandle field in Mcf. on a pressure base of 14.65 pounds per square inch absolute calculated to 25 pounds well head gauge abandonment pressure and I will ask you what it is.

A. Yes, that it what it is.

(Exhibit 186, Witness Hammer, marked for identification.)

By Mr. March:

Q. I will ask you if that estimate of the remaining gas reserves in the Texas Panhandle field was prepared by you or under your supervision?

A. It was. I assisted in it and it was prepared under my direction.

Q. I notice there that the tabulation does not contain a date. Is that as of August 1, 1939?

A. This is as of August 1, 1939.

Mr. March: Mr. Examiner, we might have that inserted on all of the copies.

The Trial Examiner: I think it would be advisable.

Mr. Spencer: Do you desire to have it inserted right under the title, Mr. March?

Mr. March: Yes.

The Trial Examiner: Yes, as of August 1, 1939.

By Mr. March:

Q. Since your cross examination has started and since you have offered your reserve of the Canadian River, you have consulted your working papers and data and have checked this estimate of remaining gas reserves, have you not?

A. Yes, sir, that is right.

Q. And it is your position that this has nothing whatsoever to do with the estimate of reserve for the Canadian River's acreage, although it does include the Canadian River's acreage reserve?

A. Except as to that part of it that lies in the territory where Canadian River has its acreage—

Q. It is your position it is independent and separate—

Mr. Spencer: Mr. March, let him state his position.

Mr. March: I have to ask him a question.

Mr. Spencer: Go ahead.

By Mr. March:

Q. Is it your position that the estimate of reserves for the entire field is not essential to your Exhibit 180 showing the estimated reserve of the Canadian River's acreage?

A. It definitely is not necessary.

Mr. March: Mr. Examiner, we offer this exhibit with the understanding that it is, as far as Commission's counsel is concerned, and that is as far as the purpose of the exhibit is concerned. We have not only gone one hundred per cent of the way with counsel here but we are now going two hundred per cent of the way.

The Trial Examiner: The Examiner may want to utilize Mr. Hammer's figures, too, Mr. March.

Mr. March: I think it would be the most accurate.

Of course, Mr. Examiner, this estimate of reserves of the whole field was not prepared in connection with this case. This estimate was in the Texoma case. We intended to offer that estimate in that case.

Mr. Spencer: When you get through there, Mr. March, you seem to be damning this with faint praise. If there

isn't any purpose for having it put in here; and you must remember that we haven't asked you to put it in here.

Mr. March: The cross examination is going to be over the whole field, so if we have to go through ~~this~~ ordeal we want to get the credit for having the reserve figure in.

Mr. Spencer: All right. It is in for the purpose of facilitating cross examination as far as you are concerned?

Mr. March: As far as I am concerned, it is an estimate of the reserve for the whole field.

The Trial Examiner: Let me straighten this out. I think perhaps the Examiner prior to the conclusion of this hearing may request just such information as has been placed in the record by Commission's counsel for whatever purpose the Examiner might want to use it for and I think with that understanding now in the record we may proceed.

Mr. March: I wish to ask this one further question:

Q. This estimate of reserves for the whole field was prepared in the same mannerism for the Canadian River's acreage as reflected in Exhibit 180?

A. The same method.

Q. The same procedure all the way through?

A. Yes, sir.

Mr. March: That is all.

The Trial Examiner: You may proceed now, Mr. Keffer.

* * * * *

Exhibit 186, which shows the estimate of Witness Hammer of the remaining gas reserves of the whole Texas Panhandle Field as of August 1, 1939, is as follows:

Remaining Gas Reserves Texas Panhandle Field.
As of Aug. 1, 1939.

In M.C.F. On a Pressure Base of 14.65 Pounds Per Square Inch Absolute Calculated to 25 Pounds Well Head Gauge Abandonment Pressure.

County and Quadrant	Quadrant Acreage	Remaining Reserve	Remaining Reserve Per Acre
Hartley-HA	32,906	451,255,418	13,713
Potter I	57,588	1,282,995,311	22,279
Potter II	44,937	728,934,688	16,221
Potter III	33,389	448,272,000	13,426
Moore I	62,173	984,144,385	15,829
Moore II	61,866	798,633,900	12,909
Moore III	56,614	677,613,658	11,969
Moore IV	28,755	546,702,305	19,012
Moore V	62,614	1,308,919,224	20,905
Moore VI	79,556	1,421,935,155	17,873
Moore VII	65,530	1,070,775,272	16,340
Moore VIII	29,198	598,765,092	20,507
Hutchinson I	9,660	192,292,250	19,906
Hutchinson II	50,658	652,228,822	12,875
Hutchinson III	53,967	608,902,312	11,283
Hutchinson IV	46,157	516,968,612	11,200
Hutchinson V	35,097	543,719,214	15,492
Carson I	52,814	1,039,002,628	19,673
Carson II	82,997	2,183,830,359	26,312
Carson III	79,985	2,277,423,428	28,473
Carson IV	40,251	1,152,417,880	28,630
Gray I	27,987	215,979,606	7,717
Gray II	22,265	188,534,855	8,468
Gray III	12,364	144,725,137	11,708
Gray IV	57,929	669,490,087	11,557
Gray V	18,310	142,699,453	7,794
Gray VI	49,744	282,587,644	5,681
Gray VII	32,334	209,302,755	6,473
Gray VIII	37,036	357,726,280	9,659
Wheeler I	23,576	—	—
Wheeler II	59,060	233,145,256	3,948
Wheeler III	51,545	359,761,692	6,980
Wheeler IV	33,553	104,698,348	3,120
Wheeler V	9,307	27,184,297	2,921
Total	1,501,719	22,420,439,224 M.C.F.	

The witness did not take into account the open flows of the wells in making his fieldwide estimate, but he did take into account the production from each well in the field. He stated that the wells along the axis of the field generally have good open flows, although he could not give the open flows of any of them. He stated that he did not find open flows essential in making his estimate.

Q. Certainly in evaluating reserves you were interested in knowing what a well would produce, weren't you?

A. In the volume removed, yes, of the metered gas.

Q. The ability to produce, weren't you interested in that?

A. Not in the sense of reserves. Open flow had nothing to do with that.

Q. What makes a large well, anyway?

A. ~~Pressure and~~ a large permeability.

Q. How about porosity?

A. Porosity doesn't have any particular relationship to the question of open flow.

Q. What is porosity?

A. Porosity?

Q. Yes.

A. It is the void existing between the solids in any given rock.

Q. It is the void space in the rock formation which is filled with gas? I say, "void filled with gas." It would be gas if it didn't happen to be something else. It is the porous space in the rock?

A. It is the porous space. As I said, it is the void between the—

Q. And porosity particularly determines the amount of gas you have in place per acre, porosity and thickness?

A. If you could determine it, it would.

Q. Answer my question.

Mr. Reporter, please read the question.

(The question referred to was read by the reporter as set forth above.)

The Witness: Well, naturally, the size of a reservoir always determines—

By Mr. Keffer:

Q. In stating again—

Mr. Lange: Let him finish his answer.

The Witness: Please let me finish.

Mr. Keffer: I beg your pardon.

The Witness: The size of the reservoir capacity always determines the amount of gas present.

By Mr. Keffer:

Q. How do you get reservoir capacity? What are the two things that determine reservoir capacity?
A. Pressure and porosity.
Q. Pressure and porosity and sand thickness?
A. Yes.
Q. Now, those are the three things and the only three things. In fact, pressure—strike that.

In fact, sand thickness and porosity are the only two things that determine reservoir capacity?

A. Sand thickness and pressure.
Q. Pressure will tell the amount of gas you can get into a certain space under a certain pressure but the space, the important thing is spaces which carry the gas, that is, the cubic content of those are determined entirely by porosity and sand thickness?
A. That is right.
Q. Then the volume of gas you have in those porous spaces is determined by the pressure you have in the reservoir?
A. That is right.
Q. Then there isn't any question if you knew sand thickness and porosity and pressure you could figure the field more accurately that way than in any other?
A. If you knew them.
Q. "If you knew them," you would go that far?
A. If you actually knew them, yes.
Q. You do know in many cases and in many fields where the porosity and sand thickness method has been used in estimating reserves?
A. In sandstone reservoirs.
Q. Sir?
A. In sandstone reservoirs.

Q. That is right.

What would be the difference in estimating a sandstone reservoir and a dolomite reservoir?

A. Because you can determine—in most cases you can determine your porosity in a sandstone reservoir because you can get out good cores, but—
Q. If you—
A. Let me finish.

—in limestone reservoirs you can't do it because you don't get out the cores and you can't determine from point to point the variables that enter into it.

Q. As a matter of fact, the early estimates of this field made by everybody were made by the utilization of the porosity sand thickness method, were they not?
A. I don't know how the early ones were—
Q. You have read of estimates, haven't you?
A. Yes, sir.
Q. Weren't they all based on that method? Did you ever see one that used the pressure decline method?
A. I believe that the early ones were.
Q. That is right.

Well, now, do you say that those fellows knew absolutely nothing about the way of determining them?

A. No, I didn't say that. I said they were jumping at conclusions, perhaps, in utilizing ideas of porosity which they couldn't substantiate.
Q. All right, what kind of an estimate would you have made if you had made one ten years ago?
A. Ten years ago?
Q. Yes.
A. Well, ten years ago I would have probably used or attempted to use the same method.
Q. You mean the pressure decline method?
A. No, I mean the—
Q. The porosity and sand thickness figures?
A. Yes. As I explained in my written statement, it is a progressive thing. In the early stages of the field where you don't have the factual data necessary you have to resort then to something else, but when you reached that point

where you do have the factual data, then the other things eliminate the earlier guessing that you were forced to employ.

Q. You then questioned the early estimates?

A. That is right.

Q. Although you would have made the same sort of an estimate?

A. In the earlier stages, certainly, because at that time there was no other way to do it.

Q. Why wasn't there some other way to do it?

A. You didn't have enough factual data over the field to utilize it.

Q. You say that you haven't enough factual data. Explain what you mean by that. Expand on that. Tell us what you mean.

A. There hadn't been enough wells drilled over the field; there hadn't been enough indices established between the volume removed and the pressure decline. In other words, you didn't have an index covering the field ten years ago that would give you the information necessary.

Q. You have a great many areas in which there have been no wells drilled?

A. A few, but in relation to the total area, they are relatively small.

Q. But you did have pressure declines, didn't you, in 1930?

A. Pressure declines in a newly developed field where there are only a few wells, it is a dangerous thing to attempt to use it at that stage of development.

Q. Well, take a situation—I still can't frame your answer. You say you don't have enough factual data where the thing would work properly. Can you state why it wouldn't work with the factual data you had at that time? Is that question clear to you?

A. I am not sure that it is.

Q. Let me see if I can't state it a little differently.

You have a situation where you use a method that you say is bad but it is the best that you can do. Obviously, you think that under the conditions of ten years ago the porosity sand thickness method under conditions then existing than the pressure decline method?

A. I wouldn't even make that comparison.

Q. No?

A. In the earlier stages you couldn't utilize the pressure decline method. You didn't have any choice.

Q. You didn't have enough tools there to do it?

A. That is right.

Q. You had to take the second best, is that what you figured?

A. Well, you can call it that.

Q. In your terminology you would rank pressure decline first and porosity second?

A. As it applies to the Texas Panhandle field I would say that in my opinion as of today where you have the great mass of factual data you have that there is no choice—

Mr. March: Mr. Keffer, May I ask a question here?

Mr. Keffer: Surely.

Mr. March: Could you in 1930 have made anywhere near an accurate estimate of the reserves as you can now?

The Witness: No, not at all.

Mr. March: Could you have made an accurate estimate at all by using the porosity thickness method at that time?

The Witness: You would have the same problem there. You wouldn't have had sufficient wells drilled over the field to have given you any information that would have particular value for the field as a whole.

Mr. March: Your estimate wouldn't have been very much in 1930?

The Witness: Not a great deal.

By Mr. Keffer:

Q. Now, as a matter of fact, Mr. Hammer, can you draw me a line and tell me how much experience you ought to have with respect to the producing formations before you can begin applying the pressure decline method with some degree of certainty?

A. Well, I think this field has reached that stage.

Q. About when did it reach it, in your opinion?

A. Well, it is a progressive proposition—

Q. I appreciate that.

A. —and more factual data were collected from year to year and from time to time whereby you could more nearly approach a condition where you ought to get the best answer.

Q. In other words, as time goes on the better your answer, isn't that it?

A. That is true.

Q. When a field is fully depleted, any one can tell how much was in it to start with?

A. If it had been properly metered out.

Q. I think I could do that. I think anybody that could add could do that.

A. That is true.

Q. I think that is obvious. The nearer you approach that the more accurate your estimate is?

A. That is correct, the more data you have.

Q. If you made an estimate next year it would probably be a little different than the estimate you are making this year?

A. It would probably have some variations.

Q. If you made an estimate last year it would be slightly different from the one you would make this year?

A. The estimate of reserves by any method is never a complete thing because of certain factors that are inherited in the problem.

Q. You haven't quite answered my question, but let me state it again.

Using the pressure decline method, every time you make an estimate from year to year you get a different figure, is that correct?

A. Well, slightly different, maybe, but not any great difference.

Q. Suppose it did differ greatly, what would you say then about it?

A. Well, if you have the right sort of factual data, and you have done the right sort of a job in the first place you shouldn't have any great variation.

Q. I know that, but still you don't answer my question.

I said, suppose you did have a great variation, what would that indicate?

A. I think I answered your question. If you have done your work properly in the first place, the corrections that you would get by the following year or two wouldn't or shouldn't greatly change the shape of any curve that you might use.

Q. Getting back to my question, suppose you had done all of that properly and suppose it does change that curve—that is my question—then what do you say about it?

A. Read that question, please.

(The question referred to was read by the reporter, as set forth above.)

The Witness: Well, if the actual facts change an answer, it is a changed answer and that is all there is to it.

By Mr. Keffer:

Q. It shows your former estimate was wrong, doesn't it?

A. Whatever slight variation there is.

Q. I am not assuming any slight variation, Mr. Hammer, I am assuming a substantial variation.

A. Well, it would prove that your previous estimate—we are assuming all the time your factual data is one hundred per cent true as near as you can get it—

Q. Go ahead and make that assumption.

A. In that case I would say that you would not have any great variation—

Q. All right, but getting back to my question, I am assuming all of that and still there was a substantial variation, then what would your answer be to that?

A. Well, I just stated that whatever the answer was would be the answer and if it were slightly higher or lower it would show that variation.

Q. You keep using the word "slightly." I am assuming it is substantially lower or higher as the case may be.

A. Well, as I see the question, and as I stated a while ago, if the work is properly done you are assuming something that isn't apt to happen at all.

Q. I know, but indulge me the privilege of making an assumption—

Mr. March: I will help you—

Mr. Keffer: I think I can do it all right.

Q. Let me make the assumption which I have made and then tell me what would be your judgment of a situation like that. What would it indicate?

A. Well, it would indicate a variation in the estimate.

Q. Certainly.

A. You might make another estimate, we will say, the next year or so and it might vary in the opposite direction—

Q. But you are still not answering my question.

A. I have. As I see it I have already answered your question.

Q. Not as I see it.

If you have made estimates on rock pressure decline method this year and you have found next year that by utilizing the same method you get a substantial variation from what you got this year, what would that indicate to your mind with respect to the availability of the pressure decline method for estimating reserves in this field?

A. I see, I think, where we are not on the track. We have not utilized any one year; we have utilized the factors over a period of five years, and I don't believe anyone is justified in taking the data from year to year and attempting to arrive at an estimate.

Q. All right, then, I will broaden my question.

Take the five-year period which you have utilized and made your estimate on and your estimate in 1939, then you find out that in 1940 you got entirely a different answer using the same method, then what would you say?

A. Well, I would say that with the added year of factual data, if there was a variable, that probably indicated the later estimate was the best.

Q. Probably? Don't you know it would be the best?

A. I said "probably."

Q. All right, then, getting back to the original question—back to the question I asked a while ago—the longer your period the better your estimate? There can't be any argument about that, can there?

A. That is true. The longer period of actual factual data, the better off you are.

• • • • •

He stated that the greater the porosity of producing formations the greater the production, but it would not necessarily follow that the greater the open flow the greater the production. He was then asked if you could produce as much gas from a five million cu. ft. open flow well as you could from a twenty million cu. ft. open flow well, and he answered that certainly you can produce more from a larger well than from a smaller one.

The permeability has less influence on gas production than on oil production. Gas will pass through a porous space with more ease than will oil. A big oil well requires a large factor of permeability but you can have a big gas well with lower permeability as compared to oil. Permeability retards the flow of gas much less than it retards the flow of oil. He didn't know whether permeability or porosity has more influence in the Texas Panhandle Field in determining the size of a well, but permeability retards the flow of gas, or the migration of gas from one point to another in a structure to a much lesser degree than is true of oil. You may have a formation the permeability of which is such that there would be little migration of oil into the well bore, yet the same type of formation with the same permeability might permit a large volume of gas to flow into the well if gas were encountered instead of oil.

Porosity, simply stated, is the void spaces existing between solids in any given reservoir. Permeability is the measure of flow of the gas through that formation. You might have a twenty percent porosity in Well A, and twenty percent porosity in Well B, but the gas would not necessarily flow as rapidly to the well bore in one as it would in the other because of the possible variation of the characteristics of the reservoir rocks themselves, such as the angularity of the material that makes up your formation. This would have some effect. For instance, you might have one reservoir filled with round rock that would have certain porous spaces. Gas under those conditions would pass through readily. You might have the same reservoir with the same porosity but the solids would be angular and of all different kinds and shapes, and yet in that case the gas would pass through it with lesser ease. In other words, it wouldn't pass through so rapidly. You have a higher

permeability in perfectly round grains of sand than in those that ~~are irregularly~~ shaped.

The gas producing formations in the Texas Panhandle Field are not composed of sand, but of dolomite. Dolomite is a rock consisting principally of magnesium and calcium carbonates, and is fairly hard. You have running through all of that dolomite formation porous spaces that are rather like pipe lines leading through there in all directions, but generally on a horizontal level, but you also have running throughout that dolomite variables in porosity. There is running through the rock producing formation hundreds and maybe thousands of porous spaces running horizontally, vertically, or at almost any level. The porous spaces may be honey-combed like a piece of honey-comb. Gas could migrate long distances in a honey-combed formation if the porous spaces were interconnected.

The pressure conditions in the Texas Panhandle Field indicate that the porous spaces throughout the field are inter-connected. This is shown by the isobar lines on the Isobar Contour Map (Exhibit 179) prepared by witness.

The witness had never examined any cores from the formation where the greatest flow of gas was discovered because they were never able to get a core out of that area, but the entire thickness of the producing formation contains more or less porous spaces and the witness had seen cores where porosity tests had been run in the harder part of the formation, and according to statements made to him, those cores contained considerable prorous spaces, but he did not recall the extent of the porosity. He probably looked at half a dozen cores in all. He made a notation concerning them but didn't have it with him. He took a photograph of the cores in question then discussed the entire matter with employees of Phillips Petroleum Company who had taken the cores out of the racks for him. He discussed the matter with the research department and with their field superintendent and geologist but he made no physical examination of the cores. The cores showed that there was more or less porosity all through the dolomite.

Permeability is a less important factor from the standpoint of gas production than from the standpoint of oil

production for the reason that gas will flow through a porous media much more rapidly than a fluid of any type, but he does not believe that permeability varies directly with porosity in the Texas Panhandle Field.

Gas under high pressure flows rather rapidly through angular obstructions, depending upon your permeability factors, and would move with more ease than would either oil or water. It would be necessary to know what the permeability was before you could tell whether the movement of gas would be slowed down under high pressures.

The witness further testified (Vol. 55, pp. 7689-7700) as follows:

Q. You know gas under high pressure flows rather rapidly in these angular obstructions you talked about, and wouldn't that have a tendency to slow down the gas flow very much?

A. It would all depend upon what your permeability factors were?

Q. I am assuming your angular situation which you referred to a while ago, your gas under high pressure would nevertheless migrate rather readily where oil or water wouldn't hardly move at all—

A. It would move through with more ease.

Q. You would have to have a most unusual situation in your porous space to slow down the movement of your gas very much under these high pressures, wouldn't you?

A. Well, you would have to know—in order to answer that you would have to know what your permeability was.

Q. I realize that, but the fact still remains that this gas will move rather readily through this porous media regardless of whether it is smooth all the way through there or whether you have these angular matters sticking out into your pores?

A. No, you can't make that comparison at all. You can't set up a condition underground and produce imaginary tubes running horizontal in a formation which gas would flow through. That sort of assumption is absurd.

Q. Will you tell me why it is so absurd?

A. I have just told you.

* * * * *

Q. Mr. Hammer, did you state this morning the number of cores Phillips Petroleum Company had taken of various wells in the field?

A. No, I didn't. I don't know how many.

Q. Do you have any idea of about how many it was?

A. No, I don't have any idea of how many it was.

Q. Would 1500 sound about right?

A: How many?

Q. 1500.

A. 1500?

Q. Yes

A. I have no idea of how many there were.

Q. How many did you see when you were looking at them in the room?

A: Well, that would only be an estimate. There were a lot of racks full of them, filling quite a good-sized shed. I wouldn't know how many there were.

Q. You are not as good in estimating the number of cores as that efficiency expert I heard of one time who was good in estimating a large herd of sheep?

A. No, I don't estimate that way.

Q. I believe you stated you made no determination of those that you saw either as to porosity or peremeability?

A. That is right.

Q. Did you get any information from the employes as to what percent was of porosity or permeability?

A. Just general statements. I made no notes on them when we discussed them.

Q. In other words, you more or less ignored those cores as having any useful service in making this estimate, is that correct?

A. Yes, I think that can be stated as being true.

Q. Do you have any idea why the Phillips Petroleum Company had those cores made?

A. They were looking for information on the produceing horizon.

Q. That is right. It was rather expensive to take those cores, wasn't it?

A. Yes,—

Q. Phillips Petroleum Company evidently thought they were worth something, didn't they?

A. Yes.

Q. Or they wouldn't have taken them?
A. Yes.
Q. Very well. What information could the Phillips Petroleum Company get from them?
A. I think they were disappointed in that they—as I stated, they never got any cores that gave them any information through that part of the strata that gave the major flows of oil or gas.
Q. Assuming they were disappointed, they were certainly very persistent in keeping on taking them, if they did take a number, weren't they?
A. It is my understanding they didn't continue that for a very large number of years for the reasons—
Q. You say those cores—

Mr. Lange: Let him finish the answer to your question.

The Witness: For the reason they found out that the pressure of the column of mud in the rotary drilling acted upon the producing horizon and had a tendency to force the mud into the formation and they had difficulty in cleaning the wells out so they did like everyone else does, they quit utilizing, as I understood it, a rotary for the completion of their wells.

* * * * *

Q. Now, you do know, Mr. Hammer, that tests of oil reserves, or estimates, rather, of oil reserves, are ordinarily made by the porosity sand thickness method, don't you?
A. It is a usual thing, I believe it is.
Q. I didn't get that.
A. I said, as a usual thing I believe they are.
Q. That is correct.
A. There are so many exceptions.
Q. That is right, there are many exceptions, but when you have a water drive, for example, where your pressures remain constant, I don't know whether there are exceptions there or not, because after all, you would have to have your porosity and sand thickness there as in other cases, wouldn't you?
A. That is right.
Q. What are the exceptions where the oil reserves are not estimated by porosity sand thickness method?

A. Well, in recent years; since proration, for example, has come into the state of Texas so strongly and where development has gone on—

Q. Where development has what?

A. Where development has gone on continuously in the field I think they varied that somewhat, but in a general even that is true as far as oil is concerned.

Q. We agreed this morning that permeability has less bearing upon gas producing formations and the flow of gas through a porous media than it does as to oil, didn't we?

A. In general we did, yes, sir.

Q. That is right. Then if you can estimate oil by the porosity sand thickness method, there is still greater accuracy in estimating gas reserves by that method, is that not true?

A. No, I wouldn't say there is any great accuracy.

Q. Your permeability factor doesn't throw you out of line so much, does it?

A. The permeability when you are estimating by porosity doesn't have anything to do with it.

Q. Is it not very common to estimate oil reserves based upon the size of the wells drilled, the producing ability of the wells?

A. I don't believe that would hold true.

Q. Are you stating that for a fact it is not true?

A. What do your mean—let me see if I get your question. You mean that you could tell the amount of oil reserve under any given amount of acreage by the flow of oil from that well?

Q. Not necessarily that. In determining the relative acre content, it is quite customary for oil companies to rely upon the producing ability of the wells for the determination of that fact?

A. Well, no. In limestone reservoirs I couldn't say that is true.

Q. I am talking about a dolomite reservoir.

A. That is what I am talking about.

Q. On what kind of reservoir is it true?

A. Well, it might be more nearly true as far as certain types of sandstone reservoirs are concerned.

Q. What would be the difference between sandstone and dolomite?

A. Sandstone is one that usually has a more uniform porosity than does a limestone or dolomite.

Q. Well,—

A. Let me finish my illustration.

Q. All right.

A. If you wanted them, I could give you five hundred of them, more or less. I have seen limestone wells where a well would come in and produce at the rate of three thousand barrels a day flowing; I have seen as many as six wells drilled on 160-acre tracts, the largest of which was never more than three hundred barrels. Now, that is a common thing to expect in a limestone reservoir as far as oil production is concerned.

Q. Do you find that is true in the brown dolomite in the Panhandle?

A. As I say, I have made no particular study of oil production.

Q. From your general knowledge you should be able to answer that question. There is a great uniformity of areas with respect to the production of oil and the size of oil wells in the brown dolomite in the Panhandle field?

A. I haven't checked them.

Q. You have found that is true in the gas section of the brown dolomite?

A. I don't know as having paid any attention to it.

Q. What makes a big gas well?

A. What makes a big gas well?

Q. Yes.

A. Well, you are talking about a big gas well in a limestone reservoir?

Q. In the Panhandle field in the brown dolomite.

A. Well, a big gas well necessarily means a large volume of gas coming out, and that is dependent largely upon the factor of the permeability surrounding a well.

Q. And what else?

A. Well, it necessarily follows that you must have a good reservoir condition.

Q. Isn't that some indication of porosity?

A. It is so, yes.

Q. That is right. If you get a big gas well you are almost certain you will have a higher porosity?

A. Not necessarily.

Q. Isn't that generally true in this Panhandle field?

A. I wouldn't say it was.

Q. Would you say it wasn't?

A. You are neglecting your permeability factor entirely.

Q. I know it, but would you say it was not?

A. Would I say it was not an indication of porosity?

Q. That is right.

A. Well, I wouldn't want to go that far, no.

Q. All right, then, you just haven't studied it from that angle, is that correct?

A. That is right. The method we used doesn't depend upon the questions of permeability or porosity.

Q. You made no particular search or investigation to determine whether that is true or isn't true?

A. As to whether what was true?

Q. Whether a big well indicates high permeability and high porosity.

A. Well, I made no particular investigation of that because it wasn't necessary from our standpoint.

Q. Then the statement I just made, as I take it, is a correct statement, then, since you attached no particular significance on the approach you made to the problem; you made no particular effort to determine what relationship, if any, did exist?

A. That is right.

* * * * *

The witness does not know the areas of maximum of open flow in the Texas Panhandle Field, it being unimportant to him to study this phase of the matter. He did know that the area of northern Moore County, for example, was an area of large per acre pound decline, but he didn't know as to open flow, whether the wells produced five million cubic feet or fifty million cubic feet. It wasn't important to him. He made no study to determine the size of the wells along the edges of the field and did not know whether they were small or large. This was not important to him.

* * * * *

The witness further testified (Vol. 55, pp. 7710-7726) as follows:

Q. Now take Quadrant 1, Potter County, the wells that you generally *fine* in that quadrant are in the north half of the quadrant, the majority of them?

A. No, I would say that the majority are about in the center.

Q. About the center?

A. Yes.

Q. You have an area in the northwest portion of the quadrant with a few wells in it. There is only one connected well there, is that right?

A. I believe that is right.

Q. So you have there a great deal of undeveloped acreage in that quadrant and you assumed that in the undeveloped acreage—I say "undeveloped," but I mean fairly good-sized areas in which wells have not yet been drilled—the wells, when and if drilled in that area, will be about the same size of the wells that have been drilled in that area?

A. Well, in my study of this situation in general I didn't go over the field making assumptions about what new wells would be. It wasn't necessary.

Q. You did assume that your acre content would be about the same as reflected by the wells already drilled?

A. I am glad you asked that question.

Q. All right, I am glad I asked you one you wanted to hear.

A. Don't interrupt me until I get through.

Q. All right, make the answer relevant to the question I asked you.

A. Surely. You take a given amount of production taken from a group of wells in an area and the larger the area where you utilize simply that production, the lesser amount of gas per acre pound than if you used a small area.

In other words, the utilization of undrilled acreage gives you a minimum reserve because you are taking a maximum amount of acreage into consideration, so the question of size of the wells hasn't anything to do with the question of reserve. You take a large area and a smaller amount of production and apply it to that area and you will get a minimum result because of the distribution over the larger area.

Q. Well, I don't think I quite understand that last statement of yours, "you get a minimum result." I wish you would explain that to me. I just don't catch it.

A. Well, suppose, for example, that you had a group of, say, ten wells on five hundred acres and it was possible—I wouldn't advise it, but take it as an illustration—you drilled, we will say, five wells on a thousand acres. You calculated and drew your isobars and calculated for that thousand acres the production per acre pound for that area.

All right. Then if you took, say, instead of one thousand acres, two thousand acres, and drilled more wells but applied it to the production from that one thousand acres to your two thousand acres you would have a lesser production per acre pound.

Q. Why wouldn't you have twice as much?

A. You would have less because you have more acreage. Your acre factor enters into that.

Q. What I am talking about is reserves. If you take two isolated tracts, one of them containing one thousand acres that has five wells upon it; then take another one that has two thousand acres having five wells that are identical in every respect in the things which you have considered in arriving at reserves, wouldn't you come out with just twice the reserve in the 2,000-acre tract more than you would come out with in the 1,000-acre tract?

A. Let's see. Your question was, if I get it, if you had identically the number of wells and the identical number of production on a thousand acres?

Q. That is right, and identical performance.

A. And the identical amount of gas had been taken out?

Q. Yes.

A. And you utilized—and you made a calculation on the smaller area?

Q. That's right.

A. Then you had an identical number of wells and an identical number of—no, and a larger amount of acreage, would your reserve estimate be larger in one case than in the other, is that right?

Q. Be twice as much on the 2,000-acre tract as on the 1,000-acre tract.

A. You are neglecting, Mr. Keffer, your acreage factor in your computation. It would be less than a smaller per acre—I am talking about undeveloped area.

Q. You mean you would have less content per acre in the two thousand?

A. You would have an indicated less production per acre pound.

Q. That is not what I am talking about. I am talking about acre content of gas in place.

A. Well, but you arrive at your gas in place by the utilization of your acre pound factor.

Q. Well, all right. Let's assume another situation. You have an area of a thousand acres in which there are five wells drilled; then you expand that area outside the lines, expand it so you will have two thousand acres with just the same five wells drilled, same performance and everything else. Would you say you wouldn't have twice as much gas under the two thousand as you would have under the one thousand?

A. Certainly not, simply for the reason that there is distribution of that gas under a large area.

Q. I know you are distributing it.

A. You would have a lesser production per acre pound.

Q. You wouldn't have as much if that was a perfect reservoir, I can understand you wouldn't have as great a per pound drop for the volume produced, but I am talking about gas in place.

A. That's what I'm talking about.

Q. How do you determine gas in place? I've got it all backwards, then.

A. Well, I'll try to explain it so that you will understand.

Q. That's right.

A. You understand, I think I have explained often enough how we arrived at our weighted pressure.

Q. Yes, I think I understand that.

A. All right. Then we take that weighted pressure and we calculate from that the production per acre pound decline as against the weighted pressure.

Q. Yes.

A. See?

Q. Yes.

A. All right, that production per acre pound decline, then you take that. You have in there production per acre pound decline. You have in there three factors, don't you? You have production; you have acreage; and you have pressure—pressure decline. All right, you simply take your acreage and you multiply that by your pressure drop;

then you multiply that by your 35.1 Mcf., see? In other words, you then have your acreage and you have your pressure and you have your Mcf. Now the *computation* of those three will give you the product per acre pound All right, then you have so many acres and you calculate the reserve for the number of acres.

Q. The production per acre pound. Then you make one more computation and you get the gas in place per acre, don't you?

A. It amounts to the gas in place per acre pound decline.

Q. Well, let's get off of that per acre pound. Now, the exhibit you introduced here this morning shows, well, I don't seem to have it here, but it shows the remaining reserves down to 25 pounds per acre, not per acre pound decline or anything else, but the number of—volume of gas per acre.

A. Yes, that is right.

The Trial Examiner: Mr. Keffer, may I interrupt you a moment?

Mr. Keffer: Yes.

The Trial Examiner: Mr. Hammer, do you make a determination of your acreage area prior to your calculation, or—

The Witness: Oh, yes, prior to your calculation. You know the total amount of acreage involved in each quadrant, see?

The Trial Examiner: Yes, and you made that prior to the time that you calculated the reserves in place?

The Witness: Prior to it?

The Trial Examiner: Yes.

The Witness: Yes, certainly.

The Trial Examiner: What I mean is, not to get down to this figure here, but I mean prior to the time that this calculation which you described was made.

The Witness: Well, the determination of the acreage in a quadrant and the determination of the weighted pressure is the first step that you take.

The Trial Examiner: Yes, that's what I wondered.

The Witness: That's right.

By Mr. Keffer:

Q. All right, now you have calculated it in Quadrant A, we'll call it, and you got an original reserve. Let's get it back to originals and we can compare it better. You got an original reserve of 10,000,000 feet per acre. You take that same setup and apply it to another quadrant that contained a thousand acres and it would naturally figure out ten million feet per acre on that one, too, wouldn't it?

A. Well, that's one way, but you are still neglecting—

Q. You can answer that yes or no.

A. Yes, you're right—

Q. Now, wait, I want to ask you another—

Mr. March: He can make an explanation if he wants to. He can say yes and then he can make an explanation.

Mr. Keffer: All right, go ahead.

The Witness: You are leaving out of there—what you have arrived at when you come down to that is a figure that has already taken into consideration the production per acre pound decline, scattered over the entire area.

By Mr. Keffer:

Q. All right, now let's talk about original reserve per acre, which is a very simple calculation to find when you have your acreage per pound decline on your method, isn't it?

A. All right.

Q. All right, now, we have got original reserve per acre of ten million feet per acre, original reserve, in Quadrant 1; then you have another identical quadrant with identical wells, with identical performance, that also contains a thousand acres, and that, since everything is identical, you would come out with that at ten million feet per acre, wouldn't you, original?

A. Now, what you mean—there is one thing that is confusing.

Q. Precisely what I said. I can't state it any clearer.

A. Repeat your question, please.

(The question referred to was read by the reporter, as set forth above.)

The Witness: You are talking about original. What do you mean by reserve?

By Mr. Keffer:

Q. Gas in place, there before any is produced.
A. I haven't given you any figures on that.
Q. I know you haven't but you could get that readily from the figure that you did give me. I could figure that out if I had what you just gave me.

The Trial Examiner: Well, now, let me see if I get your question, Mr. Keffer. You are talking about a quadrant that he has established a reserve on and then assuming—

Mr. Keffer: Another identical quadrant.

The Trial Examiner: Yes.

Mr. Keffer: With the same identical wells and performances and pressures.

The Trial Examiner: In another area?

Mr. Keffer: Sir?

The Trial Examiner: In the same area or another area?

Mr. Keffer: It wouldn't make any difference. They can be joining as far as that is concerned.

Q. Am I right in what I stated, Mr. Hammer?
A. Read what he stated.

(The record referred to was read by the reporter, as set forth above.)

By Mr. Keffer:
Q. All right, now, wouldn't you?
A. You would come out with—let's see if I get this straight. If you had one area, a small area—
Q. Yes.
A. —where you get, we'll say, ten million per acre and then identical stuff in a larger area?
Q. No, the same size area, another thousand-acre tract.
A. Another thousand-acre tract?
Q. Identical in every respect, you would get the same figure per acre content, wouldn't you?
A. If identical in every respect?
Q. Yes.
A. Exactly identical, yes.
Q. Yes, no deviation at all.

A. All right.

Q. You then get ten million per acre on that other one, wouldn't you, Quadrant B?

A. If everything were identical?

Q. That's right.

A. Oh, yes.

Q. Well, we are together that far, aren't we?

A. I guess so.

Q. There is no mistake there. Then you have twice as much in that, then throw the two quadrants together you would have twice as much in the two-thousand-acre quadrant as you would in either one of the thousand-acre quadrants, wouldn't you?

The Trial Examiner: You mean just add the two totals?

Mr. Keffer: That's all there is to it. It is very simple.

The Witness: Well, under that sort of an assumption you would have twice, all right.

By Mr. Keffer:

Q. Well, that's what I thought. I guess maybe I thought you said a while ago you would have less than twice as much under the two thousand than under the one thousand.

A. Yes, but the analogy wasn't the same.

Q. I intended to make it precisely the same. Where is the difference in the analogy? Maybe we'll learn something here.

A. Well, it's hard for me to explain it any further than I have, but the point is that if you have two areas—take your same illustration—you have two areas of different sizes in the one area, a small area, we'll say. You *arive* at a production per acre pound from the production that came from those wells in that area, see?

All right. Now, if you have an area, we'll say twice that large, as you have illustrated, and you take the same production, assume that you had the same production from the same number of wells and you spread that over the larger area, you are bound to get a less production per acre pound.

Q. Why, of course. I can understand that. It is very simple, but when you reduce that or convert that over to

original reserves per acre content, you are going to have just twice as much gas in the ground over the larger area.

A. No, you aren't.

Q. Then you would have in the smaller area.

A. No.

Q. We're right back where we started. I guess we've spent enough time on that, anyway.

The Trial Examiner: I think the record is clear on that, Mr. Keffer—I mean, I think you are talking about one thing and Mr. Hammer is talking about another.

Mr. Keffer: I think that's right, and Mr. Hammer persists in talking about per acre pound decline, while I talk about per acre content. I think that's the whole difference. I don't know whether it is or not, but we'll leave that.

The Trial Examiner: In other words, Mr. Hammer has fixed these reserves for his quadrant. Now, you were assuming two quadrants, you see, Mr. Keffer, and I think that is where the misunderstanding occurs. In other words, as I got your question you were throwing this ten thousand acres into Mr. Hammer's one-quarter in one instance, and in this other instance you are talking about two hypothetical separate quarters.

Mr. Keffer: I was trying to segregate, Mr. Examiner—reduce it to a point of acre content, if you had twice as many acres and had the same acre content you would have just twice as much gas. Now, I think that ought to work out that way in Mr. Hammer's way of figuring it or anybody else's way of figuring it, but if it doesn't work out that way in Mr. Hammer's way of figuring it, I want to know why, and if it doesn't, then I think something is wrong with Mr. Hammer's method.

The Witness: You have been talking about an acre, haven't you?

By Mr. Keffer:

Q. Yes.

A. This thing that I have just been mentioning so often is production per acre pound.

Q. I know, but that isn't what I have been talking about.

A. But that is the production per acre pound that has come out of an acre of ground.

Q. What good have you done when you get to production per acre pound if you stop there?

A. You don't stop there.

Q. Of course you don't. You go on another step and do what?

A. Well, you take your area and your weighted pressure and you calculate your reserve.

Q. You find the number of cubic feet per acre multiplied by the number of acres and that gives you the reserve of your quadrant, don't you? Isn't that right?

A. Let's see, you multiply your acreage—

Q. Your acreage content by the number of acres in your quadrant and that gives you the reserve in your quadrant.

A. No, not in the utilization of a production per acre pound.

Q. Well, just another minute or two and then I'm going to leave this. You have your per acre pound drop in pressure.

A. That's right.

Q. All right, then, tell me where you go from there and how you get there.

A. Well, I just explained it a few minutes ago.

Q. Let's do it again.

A. You take your area involved, see?

Q. The number of acres in it?

A. The number of acres, and you multiply that by the pressure drop between any two given pressures, that gives you your production—no, that gives you your per acre pound factor; then you have calculated a production per acre pound and you multiply that by the Mcf. and you get your reserve.

Q. Per acre?

A. No, for the area.

Q. For the area. All right, then, if you divide by the number of acres, then what happens?

A. You don't divide.

Q. I know, but we'll just do it this time. What would you get?

A. It would be a wrong assumption and it isn't anything that has, as I see it, a bearing on the question of reserves. You would be doing things wrong.

Q. I don't think it does much, either, Mr. Hammer, but I don't know. I'm just trying to see if it does.

Now, this Exhibit 186 introduced this morning, you show remaining gas reserves per acre in Hartley-HA, 13,713,000. Now, how did you get that figure?

A. Well, on this particular sheet I divided the remaining reserves as calculated here by the acreage.

Q. That's exactly what I said, and you just said it wouldn't give you anything, didn't you?

A. There was a misunderstanding there as to what you were trying to get at.

The witness then testified (Vol. 55, pp. 7726-7782) as follows:

Now, what causes drainage in a gas field, Mr. Hammer?

A. Pressure differential.

Q. Do you have pressure differentials in the Panhandle field?

A. Oh, yes, there are pressure differentials in the Panhandle field.

Q. Where are the lower pressure areas generally?

A. In that field in general they are along the northeast side of the field.

Q. What has made those low pressure areas on the northeast flank of the field?

A. Gas withdrawals.

Q. Where?

A. Well, along the northeast side of the field.

Q. That's right, as gas has been withdrawn along the northeast flank and low pressures were formed in there, what happened?

A. As gas was withdrawn and low pressures formed, what happened, you say?

Q. That's right.

A. Well, a lot of things happen. There was a general tendency—a general tendency for gas to move from the higher to lower pressure areas.

Q. You say "general." Isn't that an unavoidable tendency or an unavoidable result?

A. Well, there are all sorts of degrees as to the movement of gas.

Q. I appreciate that, but it moves, nevertheless.

A. It has a tendency to move all right.

Q. Well, doesn't it move? Let's cut out the word "tendency" and say that it does move.

A. It isn't that—

Q. Isn't that right?

A. Well, I would rather leave that, that the movement is a variable condition but that there is—

Q. But there is, nevertheless, a movement?

A. There is a movement.

Q. That's right.

A. It will vary in degrees very considerably.

Q. That's right, the movement is from what point to what point?

A. Naturally it is from the high to the low pressure areas.

Q. Just on the same principle that water runs downhill, isn't it?

A. Well, I suppose that would be a good explanation.

Q. It is impossible without some exterior force for gas to move from a low pressure area to a high pressure area, isn't it?

A. I have never heard of it being done in a gas field.

Q. I don't think you ever will. In fact, that is Mr. Boyle's law to a degree, at least, isn't it?

A. That's right.

Q. All right, now, the areas along the northeast flank of that structure are generally low, practically from one end of the field to the other, is that not correct?

A. No, not the entire distance.

Q. Well, let's start from a point, say in the northwest portion of Hutchinson County.

A. If you would start from an area in the vicinity of the Borger field and go from there east, I would agree with you in general.

Q. Well, why couldn't you start way north of Borger? Here is Borger, and way up here just opposite the word "Hutchinson," wouldn't you be getting low pressures there on the northeast flank of the field? I am referring to Exhibit 179.

A. They are all degrees of pressure, Mr. Keffer. That

area up there in northwest Hutchinson County in 1939 was a relatively high pressure area.

Q. That's right, but is it today?

A. So you can't say that that is a low pressure area.

Q. All right, let's take, then, from in the vicinity of Borger and going on down through the length of the field. Which direction do you go from that line to get into a higher pressure area?

A. You mean from the line that was drawn in making the limits of the field?

Q. That's right, from any point along that northeast flank. Start anywhere you want to.

A. Well, in general, it would be to the—well, toward the east—it would be to the south and west.

Q. All right, as to the movement your isobar lines show that completely, do they not?

A. Yes.

Q. And the farther southwest you go, what do you find?

A. You find higher pressure areas.

Q. That's right. You start southwest from Borger and you will find a higher pressure area, and going a little farther, still higher, and going farther, you will find it still higher, and where do you find the very highest pressure areas in that field?

A. Well, there are three of them, really, at northwest Hutchinson County, the extreme western Moore and part of Hartley County, and the area along the south border of the field.

Q. That's right, you generally find the higher pressure areas at points farther east, away from the low pressure areas along the northwest flank, don't you?

A. In general that is true except that northwest Hutchinson, I would say.

Q. Now, state again just what causes that.

A. Well, I said it was pressure differential between different areas.

Q. And the gas is migrating in what direction on that—from the high to the low, I think you stated that, is that not correct?

A. I have.

Mr. Keffer: I have another map here that is colored which I would like to put up here for just a moment. I would like for this map to be marked as an exhibit for identification. We do not desire to introduce it just now, but it will be introduced later.

The Trial Examiner: It will be marked for identification as Exhibit No. 187.

(Exhibit 187, Witness Hammer, marked for identification.)

The Trial Examiner: Did you state what the map is, Mr. Keffer?

Mr. Keffer: No.

The Trial Examiner: Would you do that?

Mr. Keffer: This map shows the outline of the Texas Panhandle gas field as determined by the Railroad Commission of Texas, showing pressure bands at 20-pound intervals in different colors in order that it might better reflect the bands of pressure differentials in the field.

This color along the northeast side of the structure here, I guess you would call it a slate color or perhaps represents pressures from zero up to two hundred pounds; that is, nothing up above two hundred in that area and nothing below zero.

The next band, which is I guess an orange color—anyway, it is this color here that I am pointing to—is two hundred to two hundred and twenty pounds pressure.

The next is a dark blue band which is two hundred and twenty to two hundred and forty pounds pressure.

The next is a pink bank which is two hundred and forty to two hundred and sixty pounds pressure.

The next is a green band from two hundred and sixty to two hundred and eighty pounds pressure, and the next is a red band from two hundred and eighty to three hundred pounds pressure.

The next is sort of a purple band from three hundred to three hundred and twenty pounds pressure.

The next, I guess is colored a light green.

Mr. March: That's right.

Mr. Keffer: A light green, from three hundred and twenty to three hundred and forty, and then a light blue, lighter than the previous blue that we referred to, is three hundred and forty to three hundred and sixty, and then, what is that, Mr. March—Mr. March says it is a brownish green. I guess that's just as good as any, is three hundred and sixty to three hundred and eighty, and then a pink from three hundred and eighty to four hundred, and then a yellow above four hundred pounds pressure.

Q. Now, will you examine that map generally, Mr. Hammer, and tell me if it is a rather accurate presentation of the pressure differentials existing in the field as of July 1, 1939?

Mr. March: Now, if it please the Examiner, we don't object to this witness answering any question in regard to the entire Panhandle field. We don't even object to the witness being cross examined about the porosity thickness method which he did not use, but we do object to this witness being cross examined about an exhibit that he did not prepare, and an exhibit which has not even been marked for identification or been offered through a witness in this hearing room—

Mr. Keffer: It has been marked for identification and I am not cross examining him on the exhibit.

Mr. March: And in so far as any testimony on this exhibit, which is not Mr. Hammer's exhibit, we think it is unfair to cross examine in regard to it and we absolutely object to such cross examination.

The Trial Examiner: I think, Mr. March, that we have a precedent. Mr. Keffer says that he is not going to cross examine Mr. Hammer on that particular exhibit, but I think we have a precedent for just such procedure established by Commission's counsel. I can recall of Commission's counsel putting on Map 95, I believe it is, and using that very map to cross examine Mr. Watson.

Mr. March: Well, that was with the consent—I mean,

he was testifying in regard to those particular—in regard to Exhibit 95 that is—is that this large exhibit here?

The Trial Examiner: That is right.

Mr. March: That was their own map.

Mr. Keffer: That is not our map at all.

Mr. March: That is their own map, their outline furnished by them to the Federal Power Commission, and as far as Mr. Watson being cross examined about that map, he was not. He was asked to designate on that map, which is merely a map of the Canadian River leases, upon which leases they were going to drill wells.

This is entirely different. There was no cross examination in regard to this exhibit here. We put a witness on and he was cross examined. He merely designated it.

Now, I don't object to Mr. Hammer coming up here and putting cresses on this map that certain leases are designated here and certain blocks and surveys and all of that, but when you take this map that was not put in through our witness and attempt to cross examine our witness in regard to it, that is something unheard of. It is something that we object to most strenuously.

The Trial Examiner: I hadn't heard of it either, Mr. March, but you have done it. It was done in regard to the examination of Mr. Watson. I don't recall whether there was another witness on it or not, but it was done on Exhibit 95, Mr. March. It is just as fair now as it was then.

Mr. March: All he did was mark on there which leases they were going to drill on, and you stopped him on that. You said it would be better for us to have our men do that because there might be some difficulty about that. We stopped that practice and didn't require him to complete marking things. We aren't relying on any markings that Mr. Watson put on Exhibit 95. Our own men took the thing—you ruled that our own men should do it and they did do it, and that is what happened, and there is not a mark on this exhibit, the map, No. 95, by Mr. Watson, that we are relying on.

The Trial Examiner: Perhaps, Mr. March, my memory is short and we will let the record speak for itself, but I don't understand that Mr. Keffer is going to attempt to verify this map through Mr. Hammer.

Mr. Keffer: Not a bit. It is just a picture there that I want to ask him about with respect to the flow of gas as indicated on that particular map. Whether that map is right, I don't ask him to commit himself on it anywhere.

Mr. March: He is going to assume it is right in the first place and then say if it is true, won't this happen. There is the whole thing in a nut shell.

The Trial Examiner: Let's just wait until we get to that point, Mr. March.

Mr. March: All right, we'll see.

By Mr. Keffer:

Q. Now, Mr. Hammer, the map, Exhibit 187, discloses a low pressure area from a point considerably north of Borger that is an area of three hundred pounds or less which is the green pressure band around here (indicating), extending from that point entirely across the field to the southeastward, does it not?

A. According to your interpretation, yes.

Q. Yes, that is what the map shows, is it not? I am not asking you to verify the map; I am just asking you to say what the map shows.

A. Well, if the green, as you said it does, goes across the map as indicated,

Q. All right, and that shows—now, the area marked here in yellow and the area marked in pink, which I am pointing to here, is in the Canadian River block, is it not?

A. Yes, it is.

Q. That shows that to be the pink—I mean the yellow to be in the highest pressure area in the field, does it not?

A. According to the interpretation of that map I would say yes.

Q. Yes. Well, do you recall a Federal Power Commission map—if it doesn't show also that the Canadian

River area is situated in the higher pressure area of the field?

A. The higher, yes, but not the highest.

Q. That's right. When I say "your map," I refer to Exhibit 179. Well, it shows this area that I am pointing to here which is the Canadian River to be—much of it to be over four hundred pounds, does it not?

A. Yes, that is right.

Q. As a matter of fact, you run out even beyond four hundred, do you not?

A. That's right.

Q. All right, now, if you were to shut in every well in the field, what would happen to the pressures in that field?

A. Well, there is a big element comes in there.

Q. Just forgetting about the time element.

A. Now, wait a minute. I am answering the question.

It would eventually have a tendency to equalize if given time enough.

Q. You say "tendency." Wouldn't it equalize?

A. If given time enough, yes.

Q. We're together on that. It would equalize, disregarding the time element. You mean by that that you don't know how long it would take, is that it?

A. Well, it would take a long long time.

Q. But you don't know how long and nobody else does.

A. And nobody else does.

Q. It would equalize. That fact is certain.

A. Eventually.

Q. That's right. Now, what do you mean by "equalize," Mr. Hammer?

A. Well, just as the term indicates so that the pressure would be equal.

Q. That means the gas from the high pressure areas would migrate into the low pressure areas until the gas in the two pressure areas were the same?

A. That's what equalize would mean.

Q. All right, now, we'll go ahead. Now we are assuming that all of the wells are shut in. The gas in the yellow area would first migrate to what area?

A. Well, part of it might migrate into that lower pressure area.

Q. The next—

A. No, I am talking about that other low pressure area you have got in the other part there.

Q. Over here (indicating)?

A. Yes, that's right.

Q. All right. The general movement would be where?

A. The general movement would be to the north and northeast.

Q. To the north and east. All right, we come up to this next pressure and which is the pink one, and what would be the movement out of that band?

A. In general it would be the same as the band we just described.

Q. That's right, and on and on and on and finally much of this gas would find its way over to Borger, wouldn't it?

A. Well, that is a question that is open to argument.

Q. What is the argument about it?

A. Well, a lot of it would never reach Borger.

Q. That's right, it would reach equilibrium before a lot of it reached there, wouldn't it? Isn't that right?

A. Well, now, that word "equilibrium," that is using another term.

Q. All right, what do you want to use—"equalize"?

A. No.

Q. All right.

A. I simply want to state that the intervening wells there would capture—use the word "Capture"—a large percentage of that gas before it ever got over to Borger.

Q. If the wells were shut in.

A. No.

Q. I said if the wells were shut in.

A. Well, eventually, yes, it would go to the low pressure area.

Q. That's right, and keep going until that hole over at Borger was filled up, wouldn't it?

A. That's right.

Q. Now, will gas migrate more rapidly where the pressure bands are narrow or where they are wide?

A. Do you mean where the pressure differential between two of your isobars where it is narrow—

Q. Let me restate it, if you prefer it that way:

Will gas migrate more rapidly where the pressure differentials are high or where they are low?

A. Well, that is a question that is controlled—well, they would have that tendency, but the actual performance would depend in its entirety upon the permeability of the producing horizon at any given area under such a condition.

Q. All right.

Mr. Spencer: I don't believe the record is clear there. You say, "would have that tendency." I don't believe the record will be clear what you mean by a tendency—a tendency to what?

The Witness: Well, we were talking about migration. It would have a tendency to migrate more rapidly.

Mr. Spencer: That's right.

The Witness: Over areas of short horizontal pressure differentials than over wider areas, but the point I want to make there is that that thing is controlled very largely or at least to a considerable extent by the permeability of the producing horizon.

By Mr. Keffer:

Q. All right, do I understand that you mean that the more permeable the formation the more rapidly the gas will migrate?

A. Yes, that in general is true.

Q. Then does not wide pressure bands indicate a high degree of permeability?

A. No, not necessarily.

Q. Why wouldn't it?

A. Well, because a lot of those—a lot of that area is—it is dropping in pressure, it isn't dependent on migration at all except locally. It is dependent upon development that has taken place there, not some place else.

Q. How do you know that?

A. I know development occurred there.

Q. You also know that drainage has occurred, don't you?

A. We also know that drainage has occurred to reduce the pressure locally For instance, out there in central Moore County, that low pressure out in there isn't due to any migration of gas over to the Borger area, it is due to

the migration—it is due to the gas that has been taken out of those wells locally.

Q. That is quite true. That is very true, but on the other hand where you do have the pressure differentials which exist in here and you have just said that if the wells were shut in there would be a migration of gas over to the Borger area, didn't you?

A. Yes, but we aren't dealing—have we got away from this shut-in yet?

Q. Not yet. We'll get away from it in a minute, but not yet.

A. I doubt very seriously, in fact, there wouldn't be anything to justify a statement that if the whole field were shut in there would be very much effect, we'll say, over in the central part of Moore County.

Q. I am not talking about Moore County. I am talking about Hutchinson County.

A. Well, you are talking about drainage, aren't you?

Q. Yes, but Hutchinson County. Just direct your statement to the thing I am talking about.

A. That's just the thing I was talking about.

Mr. March: He is explaining drainage. I realize you want the gas to move the other way.

By Mr. Keffer:

Q. You stated a while ago that it would move into the Borger area, didn't we? Do you want to take that back? Do you want to change your statement on that?

A. Well, in a closed-in condition which is an assumption that does not exist, and never will exist—

Q. Well, we have had shut-ins on a lot of wells in Texas. I have heard a lot about them.

A. It is purely hypothetical.

Q. Indulge me in that way, in that respect. The wells are all shut in, the gas is moving toward Borger. Do you still want to say that? You can change your answer if you want to.

A. No, if you would give it ample time, eventually it would equalize.

Q. All right, let's stay on Borger. We'll give you a chance to get into Moore County if you want to go up there after a while.

A. I have no desire to go up there.

Q. Those wells are shut in—I will restate it again. There is a general movement of gas into the Borger area from the southwest. That is right?

A. Under closed-in conditions.

Q. That's right.

A. You would also have it from the northwest.

Q. Answer me, if it wouldn't have moved from the southwest?

A. I said, "also," which means that you would have.

Q. I haven't asked you about the northwest.

A. I know, but I told you.

The Trial Examiner: We'll stand in recess for five minutes.

(At this point a short recess was taken, after which proceedings were resumed as follows:)

The Trial Examiner: The hearing will be in order.

Mr. March: May I ask one question here, Mr. Keffer?

Mr. Keffer: Yes.

Mr. March: Mr. Hammer, have you prepared an exhibit which shows drainage in the Panhandle field?

The Witness: Not with any particular reference to drainage, no.

Mr. March: Did you make any detailed careful study of the whole drainage problem—detailed problem of drainage in the preparation of your exhibit here, Exhibit 180 and Exhibit 186?

The Witness: No, I did not.

Mr. March: Do you feel that if you are going to testify in regard to the details of drainage that you would want to make a very careful study of that problem?

The Witness: Yes, I would.

Mr. March: And which study you have not made?

The Witness: I have not made any particular study particularly in relation to this exhibit here. I would like an opportunity to go over that thing pretty thoroughly.

Mr. March: Before you would make any statement in regard to it?

The Witness: Before making any statements, that's right.

Mr. March: I think that is clear to Mr. Keffer and to the Examiner that the witness at least has not come up here to testify in regard to a drainage exhibit which is fundamentally an exhibit in regard to that, and it is unfair to cross examine the witness about that at this time.

The Trial Examiner: Mr. March, I don't intend to require Mr. Hammer to testify to something that he is not familiar with.

Mr. March: He is only familiar with this in a general way, and if he is going to be cross examined about the drainage he should make a careful study about it and come back here and be cross examined about it.

The Trial Examiner: I understood the other day that there was an exhibit to come in.

Mr. March: There may be an exhibit to come in. That has not been prepared. There was a mistake made about that in the record. It was my fault, I think, because the way I saw this thing the whole case of the opposing side here as I see it offhand is that they are going to show that this whole field is going to blow up like a *baloon*, therefore, this drainage problem come in and plays an important role. Now, it may be that we will prepare and make a careful study of their exhibits and after that and studying the whole drainage problem, we may offer an exhibit. We haven't got one prepared now. The witness has not made a careful study of drainage in regard to these exhibits which he is offering here and I feel that when one of the geologists goes on the stand that he should be cross examined at least about the exhibit which he has prepared, not about something entirely different.

I don't feel that Mr. Hammer should be required to testify in regard to—especially in regard to a hypothetical exhibit like this, a hypothetical situation like this, on the spur of the moment without any preparation, without any study, just come in here and be asked "What do you think

of this?" on a bunch of hypothetical questions on drainage that doesn't pertain to this exhibit he is offering at all. It is unfair to the witness.

I will go one hundred per cent on everything and I believe I have, Mr. Keffer, but to take his exhibit and have a preview of his case through our witness, why, that is something that I don't feel that Commission's counsel can take the responsibility of insisting that the witness go ahead with.

Mr. Spencer: Mr. Examiner, this is very simple. All the witness has to do to stop this line of cross examination is to say, "I want to study that; I am not prepared to answer." That is all there is to it.

Mr. March: He has already said that.

Mr. Spencer: If he isn't prepared to answer questions on drainage, let him say so and we will stop. That is all there is to it.

The Trial Examiner: Well, let's go along to specific questions and if Mr. Hammer can't answer and doesn't feel that he can answer, he may say so. He is not required—I haven't required Mr. Hammer or directed Mr. Hammer to answer a question that—

Mr. Spencer: And certainly, Mr. Examiner, we don't want him to answer on anything that he isn't prepared to back up.

Mr. March: Here is the thing: When a man comes up here and introduces an exhibit on which he is prepared to answer and then he is required to answer questions on another exhibit which he hasn't studied carefully, why, naturally he is extemporaneously speaking and there are possibilities that the witness might make a mistake, and we wish to interpose the objection again. We feel that it is a serious proposition.

Mr. Keffer: If it would help Mr. March any, I don't know, I think much of it originated because I put the colored map up there, Mr. Examiner, and it is a little more tedious. I can go over the same ground with Mr. Hammer's map which shows identically the same thing.

Mr. March: All right, if you want to cross examine him about his own exhibit, that's all right.

The Trial Examiner: Now, Mr. March, I am not going to limit the cross examination to Mr. Hammer's direct examination: I haven't done it so far in this hearing and I don't intend to do it now.

Mr. March: I don't intend for you to.

The Trial Examiner: If this question of drainage comes up here and is illustrated by this particular map, I think it would be much more beneficial to all of us to visualize what they are talking about. Now, if Mr. Hammer can't answer, that is a different proposition. All he needs to do is to say so.

Mr. March: Do you know what this is, Mr. Examiner? This is really—by all fair procedure this exhibit should be put on by a witness. Let him testify as to his theory of drainage, whatever it is, and then if they want our witness to say what he thinks about it, they can ask about it, but here we come up with a map we don't even know who prepared. We don't know whether it is correct or not. We don't know anything about the map. We haven't got a witness here who offered the map.

The Trial Examiner: Let's go along. Mr. Keffer hasn't endeavored to verify his map through Mr. Hammer.

Mr. Keffer: I think we will get along much faster if we just take this map down.

Q. Mr. Hammer, we were discussing a while ago what would happen to the gas in the Canadian River area, particularly, if all of the wells in the field were shut in, and you answered, I believe, that it would migrate northeastwardly toward the low pressure areas around Borger.

A. Now, I want to explain that situation a little bit.

Q. All right.

A. I believe I stated—if I didn't, I'll state it now—that one of the fundamental things in gas movement is pressure differentials. Now, distance is quite a factor in the movement of gas. Time is also a factor in the movement of gas. Gas will move more rapidly at areas of greater pressure differential. Now, as your pressures start to equalize under

your hypothetical setup, there would be a less and less tendency all the time for gas to migrate any considerable distance, and the most rapid movement would be during any of the time—would be at the point of greatest pressure differential. You must take into consideration the distance and variables in pressure differentials.

Q. Yes, that's right. Are you through?

A. For the present.

Q. Yes, all right. Now, the present pressure differentials you speak of do exist as shown by your isobar contour lines, all the way across there, don't they?

A. But you must—the differentials are local. Now if you will step back from those, you would have a less and less gas movement and as distance came into the picture, might eventually reach a point—as you reached the point where the field, for example, had almost equalized and your differential from one point to another became less and less and approached zero, you very probably would reach a point where, because of the condition of the sand and the permeability, particularly permeability, it might take almost an indefinite, inconceivable time for the thing to completely equalize.

Q. All right, let's get down to answering specific questions, if you please, Mr. Hammer.

Now, you stated a while ago that gas would move more rapidly through a highly permeable formation than it would through a formation of less permeability, didn't you?

A. Yes. If you have a similar pressure differential.

Q. If you have the pressure differential. Let's take a very crude—a very simple illustration. Let's take a large tank the size of this room, or the size of this court house, and let us fill it with water—or let us fill it with gas to make a more analogous situation. You put a pipe line over in one side of that tank, just one side of it, and you start taking gas out of that tank. What happens to the gas in the tank?

A. Well, that is not an analogous situation at all.

Q. Wait a minute. Answer my question.

A. I am going to answer it.

Q. No, you're not.

A. Yes, I am.

Q. I'm going to insist that you answer it.

A. I'll answer your question but I'll answer your question in my own way.

Q. Go ahead, then.

A. That isn't analogous of any underground situation of which you can conceive.

Q. Won't you let me develop it step by step? I know it is not. I am not that dumb.

A. All right, go ahead.

Q. All right. When you take that gas out of one side of that tank you get all of the gas, don't you, through that one pipe on one side?

A. Well, under a condition like a room here.

Q. Yes, that's what I'm talking about.

A. But as I stated, that is not comparable at all.

Q. I'll grant you that. Let's forget about that for the moment. Suppose that tank represented the whole Panhandle field, it was that large, and you had one pipe taking it out over here at Borger, what would happen to that entire field?

A. Probably two or three million years from now it might eventually equalize.

Q. If it was in a tank.

A. If it were in a field.

Q. I said in a tank representing the size of this field.

A. Well, if it were a tank, yes, it would equalize.

Q. That's right, it would equalize with very little pressure differential, wouldn't it?

A. In an open reservoir, yes.

Q. That's right, your pressure on the southwest side of that tank would not be more than a few ounces higher than it would be on the other side of that tank, would it?

A. Well, it would probably be the same.

Q. There wouldn't be enough that you could measure the difference?

A. In an open tank.

Q. Why? You have your one hundred per cent permeability there, don't you?

A. Yes, that's right.

Q. You have no restrictions to the flow of that gas from one side of that huge tank the size of this field to the other side of the tank, do you?

A. No.

Q. All right, now, let's build a dividing line in that tank

with very minute pores—very minute, porous spaces, and then take gas out over in the Borger area. If your pore spaces are fine enough you are going to have a pressure differential, aren't you?

A. Yes, as between the two.

Q. That's right, as between the two. Why is that?

A. Well, you have set up there a hypothetical factor that deals with a question of permeability.

Q. That's right, you have an obstruction there through which the gas will not travel as rapidly as it would if it was one hundred per cent void, haven't you?

A. That's right.

Q. That is it, precisely. All right, now, the greater that obstruction, the greater will be your pressure differentials on one side of the tank and on the other side, won't it?

A. You mean the more effective that that barrier would be?

Q. All right, let's take extreme cases all the way through.

A. Well, I think I answered your question.

Q. All right, we'll put a barrier through there that is absolutely impervious; that is, gas won't migrate through it at all; then your pressures over on this side would remain at 430 pounds, if that is what you start with, wouldn't it?

A. Yes.

Q. And you take all of the gas—you can take all of the gas out over on the Borger side, wouldn't you?

A. That's right.

Q. That's right. Now, if you open that up just a little bit, have just a few porous spaces through there, where just a little gas can get through and you keep taking it out over at Borger, you are going to have an increasing pressure differential, won't you?

A. No, you would have a decreasing pressure.

Q. All right, let's make the porous spaces through the center of that tank such that when you are down to a hundred pounds at Borger you are only down to 400 pounds over here in the southwestern part of the field in the Canadian River area. You have a great pressure differential there, haven't you?

A. That would be true.

Q. Is that right?

A. That is right.

Q. But gas is moving rather slowly because of the per-

meability, if you please, of that obstruction that you have through the center. Now, isn't that right?

A. Yes, that would be the case.

Q. All right, we'll punch more holes in that, increase its permeability, then what happens to your pressures?

A. Your pressure differential would become less.

Q. That's right, the gas would come out of this western part still faster, wouldn't it?

A. Under that hypothetical condition, yes.

Q. That's right, and there would be less difference between your pressure bands on the two sides of that obstruction, wouldn't there?

A. Yes, that is right.

Q. All right, punch more holes in it and gas goes out still faster. You are still reducing the difference in pressures on the two sides of that obstruction, aren't you? You are getting less and less? Less and less differential?

A. That's right.

Q. Is that not correct?

Mr. March: You mean assuming the thing is shut in?

Mr. Keffer: No, it is going out over here all the time. It works either way. It doesn't matter.

Q. All right, now, we started with a hundred per cent permeability and lost all of our gas through the Borger area, through the pipe line leading out of the big tank over there with a hundred per cent permeability, didn't we?

A. Yes.

Q. And no pressure differential at all?

A. Under your hypothetical case, yes.

Q. All right, then, we put an obstruction in there and we did reduce the permeability from one hundred per cent and we held some of the pressure over here—or, first, we put one through there that no gas could get through at all, had no permeability and lost nothing, that is right, isn't it?

A. That is what you stated.

Q. Then we started punching holes in there. The more holes we punched in it the more gas we lost, didn't we?

A. That's right.

Q. And the more holes we punched in that obstruction the less pressure differential we had on the other side of that obstruction, didn't we?

A. That is true.

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Q. All right, then, doesn't it follow unavoidably that the greater your permeability, because we were increasing permeability every time we punched another hole in that, the greater your permeability, the less your pressure differential and the greater your drainage?

A. No, that is not true at all.

Q. Why isn't it?

A. You are disregarding entirely the question of distance.

Q. Tell me, why isn't it true?

A. You are disregarding entirely the question of distance and you are disregarding—I don't like to talk about hypothetical cases.

Q. The distance was just the same as on that field. We had assumed that.

A. You just put a barrier in there. That wasn't—

Q. The size of that Panhandle field.

A. That barrier of yours might have been the width of a sheet of paper or a hundred feet thick or five miles, you didn't state that.

Q. We'll state that—we'll put barriers in there all the way along, all the way across that field, every one an impervious barrier, then start punching holes all the way through those barriers, you are increasing your permeability, aren't you?

A. You are increasing the permeability, that is true, when you make more holes.

Q. All right, you are increasing your drainage, aren't you?

A. Yes.

Q. And you are lowering your pressure differential, aren't you?

A. That is right.

Q. Absolutely. All right, now, get back to the statement I made a moment ago, the greater your permeability the more rapid your migration and the less pressure differential you will have. I don't care what the distance is.

A. Well, of course, you increase your permeability and naturally you have an increase in flow.

Q. All right, and if you had that portrayed out on the map, the wider your pressure bands would be, wouldn't they?

A. Had what portrayed on the map?

Q. Just as you have your isobar lines on your map.

A. Now, I don't get your question exactly. What do you mean?

Q. All right, we have already agreed that the greater your permeability the greater—or the more rapid is the migration of gas from a high point to a lower point, even though the pressure differential is slight. If your permeability is there you are going to lose that gas with a minimum of pressure differential, if you have got your permeability.

A. Assuming an ideal condition, you might say, yes.

Q. Well, assuming any kind of a condition. Remember I said if you have permeability.

A. Well, you always have some permeability, naturally.

Q. I know, but the greater your permeability the greater your loss, isn't it?

A. The greater your permeability under equal pressure differentials.

Q. All right, the greater your loss.

A. The greater would be your flow.

Q. You can have greater loss of gas by drainage through a highly permeable formation with only ten pounds differential in pressure drop than you can have through a tight non-permeable formation or a formation with low permeability even though you may have sixty pounds pressure differential?

A. Well, I wouldn't answer that.

Q. I want you to answer it.

A. Well, I don't want to answer it. I am not prepared to answer it.

Q. Well, what preparation do you need to answer that?

A. I want to think it over.

Q. How long do you want to think it over?

A. Oh, tomorrow morning.

Q. You think you will have an answer then? Will it be all right if I ask you that question tomorrow morning?

A. You can ask it tomorrow morning.

Q. Will you promise to answer it then?

A. I will do my best.

Q. All right. I want to be sure. I don't want to lie awake figuring on this question if you aren't going to answer it.

All right, now, I think we have illustrated pretty well the part that permeability plays in drainage, don't you?

A. Well, it is somewhat illustrated, yes.

Q. All right. Now let's go to another phase of this thing. We are talking—we were talking a while ago about what would happen to the reservoir or to the field if all of the wells were shut in and producing no gas. Now, you didn't much want to answer that on the theory that isn't the case, that wells aren't shut in, they are producing gas; but let me ask you this:

With all of those wells producing as they are today and as they have been for some time past, this pressure differential has been created and continues to exist, is that not right?

A. Naturally you have to have pressure differential or you wouldn't have pressure at your wells, or you wouldn't have any flow.

Q. That's right, that's just at the well bore, but we have wide areas through that field represented by pressure differentials as shown by your map, your isobar contour lines show that beyond any question.

A. Oh, yes; there are pressure differentials there.

Q. That's right, and what has caused that pressure differential?

A. Gas withdrawals.

Q. That's right, heavy withdrawals along the northeast flank of that structure, isn't it?

A. That's true.

Q. And heavier on the northeastern flank relatively than on the southwestern flank, isn't it?

A. Heavier on the northeast.

Q. Relatively than on the southwestern per acre? Please state it that way.

A. Well, I'm just trying to get my geography.

Q. When I say "northeastern," I mean the northeast section of that reservoir, the northeast flank.

A. Well, I think we have already agreed there is no gas out there.

Q. I mean within the gas producing area as you have outlined it here.

A. Well, yes, the pressure differential also extends from the area to the northwest. It also extends—

Q. I know, but will you please answer my question, Mr. Hammer?

A. I am answering the question.

Mr. Keffer: Read the question, Mr. Reporter.

(The question referred to was read by the reporter, as set forth above.)

By Mr. Keffer:

Q. Now, can you answer that simple question?

A. You are talking about the northeastern flank of the entire fold?

Q. That's right.

A. That's right, I didn't understand you.

Q. And the gas withdrawals have been heavier along the low pressure areas existing along the northeast flank than it has been back farther to the southwest?

A. Yes, that is right.

Q. And that has caused these pressure bands, hasn't it?

A. Yes, that has caused your pressure differentials.

Q. All right, now, you started to state a while ago that there had been heavy production up in the north part. What did you want to say on that? I wanted this other question answered first.

A. What was your statement?

Q. You started a voluntary statement, not in answer to my question, and I wanted to give you the opportunity to state what you had in mind. What did you want to say on that?

A. Well, that came about by misunderstanding of what you were trying to get at in the succeeding question.

Q. Yes.

A. Now since we have understood and decided you meant as between the two sides of the field, why, then I don't have any statement to make.

Q That's all right. I wanted to give you an opportunity to state what you had in mind.

A. I didn't have anything in mind after we got that straight.

Q. All right, now, as a matter of fact, if gas had not been migrating from the southwestern to the low pressure areas in the Borger area, you wouldn't have had these pressure differentials ranging out to the southwest, would you?

A. No, nor I wouldn't have them to the northwest or locally there at the southeast.

Q. That's right, if there wasn't a migration of gas every place you have a well, you have a local low, just a circle around that well, and go over to another one, and just a circle around it, you would have a series of circles around that field, if no migration of gas except locally to local well bores, isn't that a fact?

A. You would have a condition similar to the condition that has developed and is developing up through central Moore County.

Q. All right, and instead of having—you mean you have two or three local lows?

A. That is right.

Q. Instead of having two or three local lows you would have two or three thousand local lows if there was no migration of gas from the general high pressure area to the general low pressure area?

A. No, I don't agree with that statement.

Q. Well, what's wrong with it?

A. As I said a while ago, you are trying to move gas in mass over long distances.

Q. No, I'm looking at a picture which you have drawn yourself.

A. So am I looking at that picture, and where is your rapid pressure differential? It is right there in the vicinity of Quadrant 1, Hutchinson County. Now, when you get away from that a very short distance, that rate of pressure differential rapidly changes and it flattens out, more or less, into a low—

Q. Wait a minute.

A. I haven't finished.

Mr. March: Let him finish his answer.

The Witness: It flattens out into a local condition extending from approximately here on (indicating).

Mr. March: Which way?

The Witness: To the west.

Mr. Lange: In Moore County?

The Witness: In Moore County. In other words, taking in approximately the center of Quadrant 1 in Moore County and a little piece of the center of Quadrant 6 in Moore County. From there on west the pressures have almost

flattened out. Your movement of gas is dependent there in that case upon your local pressure differential from here on east (indicating).

Mr. March: Where on east?

The Witness: Well, from about the center of Quadrant 1 and Quadrant 6 in Moore County over towards the Borger area.

By Mr. Keffer:

Q. And over into the Borger area?

A. That's right, but it only extends into about the position of this here (indicating).

Mr. March: Which here?

The Witness: Into the position of the center of Quadrant 1 and Quadrant 6 in Moore County. The drainage is over in this part of the county due to gas withdrawals on the southwestern part, being taken out of there, and still being taken out.

Mr. March: The western part?

The Witness: The western part of Moore County.

By Mr. Keffer:

Q. How do you know that?

A. Well, I know it from my study of the pressure isobars over the period of the last five years in the construction of the maps.

Q. All right, I thought we just agreed after lengthy argument, almost, a while ago, that the greater your permeability the wider the pressure bands and the less pressure differential you had, didn't we agree on that?

A. No, I don't think we—as I understand you now, we did.

Q. How do you understand me now as compared to how you understood me then?

A. I don't know what you are driving at right now. You seem to be—

Q. Have we got to go through all that again?

A. I don't care if it takes a week.

Mr. Keffer: I don't either.

The Trial Examiner: I think, gentlemen, that the record, of course, will speak for itself and perhaps Mr. Hammer did not understand at the time of his previous answer, but my understanding of your response to Mr. Keffer was exactly the same as Mr. Keffer states it, and if that was incorrect, let's correct it and start over.

The Witness: Exactly as his statement concerning what?

The Trial Examiner: The statement he just made.

The Witness: What was the statement he just made?

(The record referred to was read by the reporter as set forth above.)

The Witness: Well, I think that the explanation I made there of the flattening out of those isobars explained that. It automatically shows a flattening of the pressure as you get away from the Borger area.

Mr. Keffer: Well, all right.

Q. Take the pressure bands which you have which is depicted on your map, on 179, and it shows a rather rapid decline in pressure between a point, we'll say midway, approximately, of Quadrant 3 in Hutchinson County and Quadrant 1 in Moore County, doesn't it?

A. Yes, locally that is true, in that area.

Q. All right, now, take your production over in Hutchinson County, has it been at a higher rate or a lower rate than the production out in immediately to the west in Moore County?

A. I believe that it has been at a higher rate.

Q. Higher rate, that's right; otherwise, you wouldn't have those pressures, isn't that right?

A. That is right.

Q. That is the thing that makes them.

A. That's right.

Q. All right, let's take a situation—let me ask you this: In your study of this field you studied your pressure declines primarily in making your estimate of gas reserves, didn't you?

A. We studied our weighted pressure decline.

Q. All right, did you find an area in Hutchinson County

in which the pressures generally were increasing in the wells in that area?

A. Over a five-year period I found no place where they were increasing but a local area where over the five-year period the pressures remained approximately static.

Q. Did you find any in the last three or four years in which they were increasing substantially as much as twenty pounds—twenty-five pounds?

A. No.

Q. You didn't find any of those?

A. No.

Q. Suppose you had found some of those, what would that have indicated to you?

A. Well, it might indicate several things. When you go to dealing with the pressure of an individual well,—

Q. I am talking about a group of wells in an area, not just one well.

A. You mentioned a well.

Q. I will change that, then, to a group of wells in an area.

A. Well, you would assume, of course, that in this group of wells that you are talking about there would be smewhat of an increase of gas to those wells.

Q. Of course, that is obvious, isn't it?

A. Sure.

Q. How do your suppose that gas got there?

A. Well, it probably migrated there from—not—

Q. Well, suppose, though, during all that time we are producing substantial volumes of gas, would that indicate anything to you?

A. Well, it all depends on the area you are considering.

Q. Well, any area.

A. All right. You know, of course, that there has been in that Borger area some repressuring?

Q. That's right. Yes, I know that, and that is the reason I am asking you these very questions.

A. Now, that repressuring automatically, while it was going on, at least—I don't know whether it is still going on or not—but while it was going on it automatically increased the pressure on the wells around close to it; that is, where the wells were utilized to put the gas into the ground.

Q. That's right, and that repressuring was going on while those wells in the Borger area were producing large volumes of gas.

A. Well, I don't remember now exactly when it was going on but I knew that did do some repressuring.

Q. You never knew any of them cutting down production particularly in the Borger area, did you; that is,—or, shutting them in,—I'll state it that way. They did cut it down some.

A. No, I think they are still producing.

Q. They are still producing and they were still producing during that time and today more gas per acre in the Borger area and Sanford area than they are in the Canadian River, aren't they?

A. Yes, that is true.

Q. All right, now, if they are producing that large volume of gas in the Borger and Sanford area, that general area of Hutchinson County, producing more gas per acre than they are out in the Canadian River area and in spite of that pressures are increasing or at least aren't decreasing, what is the only possible explanation for that phenomena?

A. I will answer that by a qualification. You are attempting to paint a picture here that all of the gas that is going into that Borger area comes from Canadian River acreage.

Q. No, no, I am not doing any such thing.

A. Why not mention the fact then, that it is coming in from the north and west.

Q. All right, where is it coming from?

A. The pressure isobars indicate where it is coming from. It is coming from the north, if it is coming at any particular rate. It is coming from the north, it is coming from the northwest and it is coming from the west.

Q. How about the southwest?

A. Well it is also coming from the southwest some.

Q. The whole point is, Mr. Hammer, that that gas into that area, at least, is necessarily migrating long distances, isn't it?

A. No, that is not true at all.

Q. All right, take the wells to the north and the northwest and the west and the southwest and you have heavier

production of wells in that area than you have back in Potter County and in Moore County, now, isn't that a fact?

A. That is true.

Q. All right, if that is true—

A. That is just the point I make.

Q. All right, fine.

A. If you have wells, say, up here in the northwest part of Quadrant 3 drawing gas out up there—

Mr. Lange: What county?

The Witness: In Hutchinson County, those wells locally there, are the reason why you get that pressure differential. It is not this area down here (indicating).

By Mr. Keffer:

Q. All right, how do those wells up there locally make that pressure differential?

Mr. March: What he means is down over here (indicating).

The Witness: I mean the Borger area.

By Mr. Keffer:

Q. Be more specific as to the pressure differential caused by production in the northwest part of your Quadrant 3 in Hutchinson County.

A. Well, I happen to know that there are wells up in there producing gas.

Mr. March: Quadrant 3, Hutchinson.

The Witness: And I happen to know that right across here in Moore County that there is a low pressure area. There has been a low pressure here for a long time. Now, the wells are taking gas out in there.

Mr. Lange: Where? Be specific.

The Witness: Just in this Quadrant 3, just across into Moore County, are the wells that are responsible for that pressure differential. It is not long migration down through to the Borger area.

By Mr. Keffer:

Q. The area you are talking about is a low pressure area. All right—as shown by your map, isn't it?

A. Yes, that is right.

Q. All right, now, certainly those wells from that area aren't feeding the Borger area, are they,—they couldn't be?

A. No, that is true.

Q. Of course not. We have eliminated the northwest part of your quadrant, haven't we?

A. Wait a minute. We haven't either.

Q. All right.

A. You come out this side and you still have a pressure differential.

Mr. March: Quadrant 3, Hutchinson?

The Witness: Quadrant 3, Hutchinson County. You come over here in Quadrant 4 Hutchinson County and you still have a pressure differential coming down into your Borger area.

By Mr. Keffer:

Q. Those pressures running back this way—

Mr. March: "Back this way," which way do you mean, Mr. Keffer—northward?

Mr. Keffer: Yes.

Q. All right, maybe we have spent enough time on that. Let's summarize a minute. You have wells in an area in Hutchinson County in which pressure is either holding its own or increasing somewhat, wells around it producing large volumes of gas and the gas is coming from somewhere to repressure those low pressure areas.

A. Yes and in a condition like that it is just as apt to be coming from pressure differentials in local areas, more apt to be than it is from long distances.

Q All right now, when you say "those local areas," you mean near by?

A. Near by.

Q. All right, if those nearby areas are themselves producing large volumes of gas, then the chances are they are just catching some of it as it goes by, isn't it?

A. Well, they have an effect, of course, on pressure, and they also, as stated, they capture a lot of the gas if it has a tendency to migrate back.

Q. That's right, and there is nothing as shown on your map or any other map that I have ever seen that would indicate that the acreage near by those areas that are being repressured is furnishing the gas for that repressuring?

A. I don't agree with that. I want to call your attention to just one thing here.

Q. All right.

A. Right up here in this part (indicating).

Mr. March: Now, be specific as to the designation, because the record won't show what you are pointing to if you don't.

The Witness: All right, Quadrant 6, Moore County, prior to 1939 there had been no wells drilled in this immediate area.

Mr. March: Which area is that?

The Witness: The southwest corner of Quadrant 6. There were some wells drilled in there in 1939. Prior to that time, because here was a low pressure area and some wells here—

Mr. March: Where is that?

The Witness: Along the eastern side of Quadrant 6, Moore County, and there were producing wells as far as Quadrant 6, Moore County, with no intervening wells. The only thing you could do was assume a gradual slope because you had no other data.

All right, in 1939, four wells were drilled here. I will give you the names of them. Now, after these wells came in I didn't have the pressures on the wells so a letter was written to the Texas Railroad Commission under date of March 20th, 1940 and they gave the names of these wells and their closed-in pressures. The wells are the O & H—no, the Panhandle Eastern, J. T. Sneed in Section 1—Sneed 1 in Section 3—Exhibit 95—In Section 3 on the O & H Lindsay Survey, Moore County. That well had an initial rock pressure of 350 pounds, completion date of September 19, 1939.

The other well is also on the Owen H. Lindsay Survey in Section 4—

Mr. Lange: What County?

The Witness: Moore County. That well was completed on October 11, 1939 with a pressure of 332 pounds.

The next well was the Shamrock Oil & Gas Company's J. T. Sneed, Sections 1 and 2, on the Joseph H. Johnson Survey in Moore County. That well came in on September 10, 1939, with a pressure of 370 pounds.

The last one was the Texamo Natural Gas Company's J. T. Sneed, 21-P in Section 72—I think that is Section 72,—the G & M, Block B-3, Moore County. That well had a pressure of 321 pounds.

Now, the point is that although there had been apparently greater distance extending into the low pressure area, the Moore County-Hutchinson County line, here was a well drilled in 1939 in Quadrant 6 that had a pressure of 50 pounds higher than wells to the west, which seems to indicate that a drainage in the past and drainage even now is not all in that direction.

Mr. Keffer: Let me ask you a question with respect to that, Mr. Hammer.

Q. Those wells that you have referred to were drilled in a larger area in which no wells had been drilled previously, that is correct, isn't it?

A. That is true.

Q. You had some pressures that were down to 320 pounds or 323 pounds, I believe, one of them—

A. That is right.

Q. And what is the pressure of one of the others?

A. The lowest was 321 pounds.

Q. 321 pounds?

A. Yes.

Q. That area had lost how much gas?

A. What?

Q. That well had lost how much gas up until it was drilled?

A. I don't know how much gas was lost. I know what the pressure drop was.

Q. All right, what was the pressure drop?
A. You mean from the original field pressure?
Q. That is right.
A. Well, it was 109 pounds.
Q. For all intents and purposes that is one-fourth of all of the entire gas that was there originally?
A. One-fourth of the original pressure.
Q. Wouldn't that be a fourth of the original amount of gas to zero, and not to your 25 pounds?
A. Well, I—
Q. Let's get at it this way: Your original pressure there was 430 pounds?
A. I assume it was.
Q. Haven't you made that assumption all over the field? You say so in your statement.
A. Yes, I assume it.
Q. You lost 109 pounds, didn't you?
A. That is right.
Q. That is more than a fourth of 430 pounds, isn't it?
A. All right—
Q. Wait a minute.
A. I am agreeable to that and in that same list—
Q. All right.
A. —you had a well with a 50-pound pressure and wells to the west.
Q. We will come to that in a minute. There is a tract of land that had never had a well on it—
A. No, it hadn't been drilled previously.
Q. It was the first well on the tract?
A. That is right.
Q. You drilled into that formation and found that more than one-fourth of your gas had gone somewhere, didn't you?
A. That is right.
Q. Where did it go?
A. It went to the closest well that could drain it.
Q. What were the closest wells that could drain it?
A. Well, I would have to check on that.
Q. All right.
A. These wells in this area over here in Quadrant 6, Moore County, would be one of them.
Q. In which portion?
A. Along the southeastern line.

Your next closest well to that would be slightly over a mile.

Q. What was the name of that well?

A. I was just going to give it to you.

Q. All right.

A. It was the Texoma Natural Gas Company, J. T. Sneed, 21-P, Section 17, G & M Survey, Block GM-3.

Q. All right, that is the well we are talking about?

A. Yes. Section 72 is correct.

Q. The question is, "Where did the gas from that well go?"

A. The closest well was down here about a mile and a half. It is on the Charles Ragsdale Survey in Moore County.

Q. All right, what is the pressure of that well? I believe the map shows it to be above 330 pounds. If that is true it couldn't have drained to that well, could it?

A. I couldn't read them off of this map.

Q. Let it go. Maybe we can straighten that out later.

The Trial Examiner: What did you say, Mr. Keffer?

Mr. Keffer: Just let that go. Maybe we can figure it out a little later.

Mr. March: Mr. Hammer will get that information for you, Mr. Keffer.

Mr. Keffer: That is all right.

The Witness: I can get the information for you but I can't tell right now.

Mr. March: Is that the Texoma well you are referring to?

The Witness: No, not this one. However, I am not sure of that because I can't check it from this map.

The Trial Examiner: You are sure of the well, Mr. Hammer, that Mr. Keffer asked about?

The Witness: Yes, I know the location of the well.

By Mr. Keffer:

Q. What is the next low pressure of the three wells you gave?

A. The next lowest pressure was 332 pounds.

Q. All right, that is the Panhandle Eastern, and where is it located?

A. No, that is the Shamrock Oil & Gas, J. T. Sneed 16.

Q. Will you locate that for us on the map? Can you state the location of it?

A. That well is in Section 4, the center of Section 4. It is on the Owen H. Lindsay Survey, Moore County, Texas.

Q. That acreage is demonstrated by the original pressures on that well having lost virtually a fourth of all of the gas that was there to start with?

A. Yes, approximately.

Q. In fact, more than a fourth, if you consider the 25-pound abandonment pressure?

A. It had—

Q. Wait a minute. Hadn't it?

A. It had lost—

Q. More than a fourth if you would consider the 25-pound abandonment pressure?

A. That is about right.

Q. And it had never produced a foot of gas, had it?

A. No.

Q. It had lost it all by drainage, hadn't it?

A. Yes.

Q. Where had it drained to?

A. The closest well to the west, being about two miles.

Q. Do you think it was lost to the west?

A. The closest well that is indicated where it could drain to would be to the south about three miles.

Q. Aren't you in the same pressure band when you go south? You don't get in the lower pressure band, do you?

A. Well, one of the wells is in this same pressure band—the same isobar, and the other one is on down a little lower.

Q. Which one is a little lower?

A. The one to the northeast. I would have to check those wells to tell exactly where they are.

Q. The one to the northeast could not drain to the south but a little lower?

A. The one to the northeast indicates that it drains locally to the north.

Q. As a matter of fact, if you will follow that out to the nearest well in the low pressure band, you go several miles from that point, don't you?

A. I want to find this description here.

Q. All right.

A. You failed to point out the high pressure wells.

Q. Wait until I get to it. Don't expect me to take all of this at once.

A. Over here is the Joseph Johnson—

Q. Wait a minute. You are getting into the high pressure wells and I am not wanting to get into that.

Mr. March: He is answering the other question.

The Trial Examiner: Why not let Mr. Keffer cross examine the witness in his own way, Mr. March?

Mr. March: I am, but he is coming in here and asking a general question as to where that gas drains to.

Mr. Keffer: When I asked him about drainage of a particular well I wanted him to confine his answer to a particular well.

* * * * *

Witness Hammer further testified on cross examination (Vol. 56, pp. 7785-7787,) as follows:

Q. Now, Mr. Hammer, just checking up a little on some of the matters that were covered generally yesterday, I believe I asked you if it was not very common in the oil industry to estimate reserves of oil-bearing sands based upon the potentials of the wells. When I say "potentials," I mean the producing ability of the wells; and as I use that term with respect to an oil well it is synonymous to open flow of a gas well.

A. No, I didn't—

Q. You don't know?

A. No.

Q. How long have you been in the oil business?

A. I started in 1912.

Q. All right, let me ask you this: Isn't it a fact that you have known many cases where oil production has been purchased—what I mean by that is that producing leases have been purchased—by persons experienced in the industry on the basis of so many dollars per barrel of potential?

A. Well, I wouldn't say yes. It has probably been done but that doesn't prove anything.

Q. Answer my question. Don't you know of many instances where it has been done?

A. On the potential of the well?

Q. So many barrels potential.

A. I think it has been done.

Q. Don't you know it has been done?

A. I never bought and sold—

Q. I know you haven't. I asked you if you didn't know of many many sales of that character.

A. I know of some.

Q. That has been spread over the entire period of the well?

A. Yes.

Q. The purchase of those properties were generally by pretty experienced oil men?

A. Yes, sometimes they were and sometimes they weren't.

Q. But they were generally?

A. Well, usually, yes.

Q. That is right. All right. Now, regardless of whether that was used to estimate reserves or not, it was used as a measure of value, wasn't it, of the potential of the well?

A. It was used as to what they thought the value was at that moment.

Q. And experiences have apparently justified that assumption, haven't they?

A. No, I don't think so, not in all cases.

Q. It has been done ever since 1912, hasn't it?

A. Yes, but I know of cases where wells have been bought on potentials that never even paid out.

Q. But still the practice is pursued, isn't it?

A. Yes.

The witness stated that he was also generally familiar with published reports on the Texas Panhandle Field which utilized the porosity sand thickness method for the determination of gas reserves, which reports were published in the American Association of Petroleum Geologists. He stated there is no absolutely perfect method for determining gas reserves. It is simply a question of the degree of perfection, and there is no method that he knows of that will give the correct answer. The witness believes that the pressure decline method has a decided advan-

tage over the porosity sand thickness method in the Texas Panhandle Field today. There was a time when the pressure decline method did not have an advantage over the other method, but he could not tell exactly when this was.

Witness began his study for the purpose of making the reserve estimate in 1935 and stated that if he had been making the estimate in 1935 and did not have dependable data prior to that date, he would still probably have attempted to use the pressure decline method, but with the understanding that his results would not have been very accurate, and from his viewpoint neither the pressure decline method nor the porosity sand thickness method would have been very accurate prior to 1935, and that prior to that time any estimate on the reserves of the Texas Panhandle Field would have been pretty much of a guess.

The witness stated that his method of determining the reserves for each quadrant wouldn't show the most prolific areas within that quadrant as compared with the less prolific areas, but would show some variation as between quadrants. For example, Moore County, Quadrant 2 was given an acre pound drop of 36.82 where Carson County, Quadrant 4 was given an acre pound drop of 81.43, which would indicate that Carson County Quadrant 4 was more than twice as productive as Moore County, Quadrant 2.

The witness Hammer further testified (Vol. 56. pp. 7802-7943) as follows:

Q. Mr. Hammer, you probably think you have already explained how you balanced your quadrants. You make a statement in your written statement that you did balance the quadrants—

A. Well, "balance" might not be the right term.—

Mr. Spencer: Let Mr. Keffer finish the question.

The Witness: —as it is really a grouping of the quadrants.

By Mr. Keffer:

Q. I would like to have you go somewhat into detail as to the manner in which you accomplished that.

A. Well, let me finish my answer.

Q. I beg your pardon.

A. Taking, for example, the one quadrant 3 used for illustrative purposes, that will explain it. The map shows that if you take Quadrant 3, Potter County, there is indicated by the isobaric lines a local movement of gas from Quadrant 3 in Moore County and Quadrant 2 in Moore County into the area in Quadrant 3, Potter County.

Now, you could not just utilize that area and make your calculation, so what we did—this is also indicated in the southeastern part of Hartley County into Quadrant 1—Quadrant 3, Potter County, a movement of gas down into Quadrant 3, Potter County, from Hartley County. There is also an indicated movement based upon the isobaric lines from Potter Quadrant 3 into Potter Quadrant 2; also there is an indicated movement of gas from both Quadrant 2 and Quadrant 3 in Potter County to Quadrant 2 in Moore County.

Now, obviously, to get a fair picture of what you would expect in this quadrant—

Mr. Lange: You mean Quadrant 3?

The Witness: Quadrant 3, Potter County, yes.

—you had to utilize Quadrant 2, Potter County; Quadrant 2, Moore County, and Quadrant 3 in Moore County, but that part of the field in Hartley County and Quadrant 3 in Potter County, by grouping those I arrived at a figure for the entire area; that is, the production per acre pound.

Mr. Lange: Which entire area?

The Witness: The entire area of the quadrants just named.

Then having arrived at that production per acre pound decline, I then took the weighted pressure, the difference between the weighted pressure of '39 and what I called the functional pressure, or the difference between the weighted pressure and the well head pressure of 25 pounds abandonment, and applied that weighted pressure—that weighted production per acre pound against the weighted pressure for this area.

By Mr. Keffer:

Q. That being true, why wouldn't you get the same per acre pound drop in each of the five quadrants we have been discussing?

A. You mean as finally arrived at?

Q. Yes.

A. I can explain that very easily.

Q. All right.

A. When we moved—take Moore County, Quadrant 2—

Q. All right.

A. When we moved over to Moore Quadrant 2 I eliminated this Hartley County and I simply took those quadrants adjacent to Moore Quadrant 2—

Mr. Lange: Which one?

The Witness: That would be Moore 3; Potter 2 and 3; Moore Quadrant 1; Quadrant 1, Potter, and Moore Quadrants 4, 5 and 6, and utilized those quadrants to get a factor for Quadrant 2.

Mr. Lange: Moore County?

The Witness: Quadrant 2 in Moore County.

Then I stepped over to the next one and I eliminated all of this over here (indicating).

Mr. March: What do you mean by "this"?

The Witness: All of these quadrants over here (indicating).

Mr. March: You mean to the west?

The Witness: And to the west.

And took in those adjacent to this quadrant.

Mr. March: Which quadrant?

The Witness: Quadrant 1, Moore County.

I utilized those surrounding it to arrive at this in Quadrant 1 and so on. In other words, that system was progressing clear across and eliminating continuously those at the west that had no particular bearing and couldn't have any particular bearing on the quadrant in question.

By Mr. Keffer:

Q. Now to get down to specific cases, when you figured Hartley County, Quadrant 3 in Moore, Quadrant 2 in Moore, Quadrant 2 in Potter, and Quadrant 3 in Potter, in order to find the acre content decline in pounds—in Potter Quadrant 3—what composite figure did you get before you made any adjustment?

A. That composite figure is a composite figure that is shown here on Table 3—

Mr. March: Exhibit 180?

The Witness: Exhibit 180.

By Mr. Keffer:

Q. You got 36.82?

A. That is right.

Q. I was looking for a cross on the exhibit here.

A. Which one are you talking about?

Q. I am talking about these five; that is, Hartley, Moore County 3, Potter County 2 and Potter County 3. I guess that is this figure here?

A. No, this is Hartley County. The next one is Potter 1.

Q. Well, now, let's get back to this. We are talking about this Hartley County area, particularly Quadrant 3 in Potter County.

A. All right, that is 35.1—

Q. That is right.

A. —per acre pound.

Q. 35.1., All right. When you figured these five quadrants we are talking about you didn't get 35.1, did you?

A. Absolutely. That is what this figure is here.

Mr. March: Where is that—in Exhibit 180?

The Witness: That is right.

By Mr. Keffer:

Q. That is the table for Quadrant 3?

A. It is the table from the calculation of the areas adjacent to Quadrant 3 applied to Quadrant 3.

Q. Let me see if I get that straight.

In determining the acre pound drop in Quadrant 3 you figured in the Hartley County quadrant, Moore Coun-

ty Quadrant 3, Moore County Quadrant 2, Potter County Quadrant 2, Potter County Quadrant 3, and you got a composite figure for acre pound drop in pressure which was 35.1?

A. That is right.

Q. You got that as applicable to the whole area and applied that to Quadrant 3, is that right?

A. That is right.

Q. I understand now. I thought you had another step in there in which you made some further adjustments with respect to Quadrant 3—

A. No, that is the entire procedure.

Q. When you did that you didn't figure in any other surrounding quadrants other than those just named?

A. Other than those adjacent to the quadrant for which we wanted to make our determination.

Q. Now, as a matter of fact, Mr. Hammer, when you did that you gave some weight in Quadrant 3 to producing areas in other quadrants, didn't you?

A. Yes, you take those all into consideration.

Q. And let us assume that Quadrant 3, for the purpose of this statement, is a very lean quadrant with a small amount of gas per acre; let us assume also that some of these other quadrants are very much richer per acre with a lot of gas in place, then haven't you unduly intensified Quadrant 3 with respect—

A. Let's make one more assumption you left out.

Q. All right, your answer would be no?

Mr. March: Just a minute. He is answering now. He hasn't said no yet.

The Witness: I will say no.

Mr. Keffer: You will say no and then go ahead and make your explanation?

The Witness: Here is an area—

Mr. Keffer: "Here," what do you mean by that?

The Witness: Wait a minute. You fellows don't give me a chance to answer a question.

Mr. Keffer: Mr. March was in on this, too.

Mr. March: You will have to describe the areas better.

The Witness: I will.

Here is an area in Quadrant 4 in Moore County, and here is another, Quadrant 3 in Moore County, extending over into Quadrant 3; Hartley County. I think this will clear up something that was confusing you yesterday. At any time you include an area where there has not been any actual or indicated decline in pressure in a calculation where it goes back, we will say, to the original pressure, and you have no indicated pressure decline as shown by your isobars, if you include that as against the production coming out of the areas around it, you then have a very minimum estimate of reserves in that area.

Taking the minimum there it would more than off-balance any other area that would enter into this calculation—

Mr. March: You said, "there"—

By Mr. Keffer:

Q. That is a matter of judgment?
A. It is somewhat a matter of judgment.
Q. Isn't it entirely so?
A. No, it isn't entirely so.

Mr. Keffer: All right. Go ahead, Mr. March.

Mr. March: I don't think you identified that last statement.

The Witness: It is Quadrant 3, Moore County.

By Mr. Keffer:

Q. What quadrants did you use on Hartley County in figuring the reserves there, Mr. Hammer?
A. (Pause).
Q. It doesn't have a number? It is called HA Quadrant, isn't it?
A. There is only one there.
Q. Yes, that is true.
A. I used Hartley, Potter 3—I notice there is a mistype here. That should be "Moore 3" instead of "Moore 2"

Mr. Lange: What table is that?

The Witness: That is on Table 3.

Mr. Lange: Exhibit 180?

The Witness: Yes, sir, tnat is right.

Mr. Lange: We might be able to make that correction at this time.

The Witness: The correction is that instead of being Moore 2 as it is typed here it should be Moore 3.

Mr. Lange: Where should the correction be made on Table 3?

The Witness: In Column A, right after "M-2." That ~~should~~ be "M-3."

Mr. Lange: Under "Hartley"?

The Witness: Under "Hartley."

Mr. Lange: The second line under Hartley that says M-2, should be M-3?

The Witness: That is right.

Mr. Lange: Mr. Examiner, can that correction be made in the exhibit?

The Trial Examiner: That correction will be made.

Mr. Hammer, I gather that these capital letters appearing under Hartley and Potter 1, 2 and 3 and Moore 1, represent the county?

The Witness: That is right.

The Trial Examiner: The county for each particular quadrant?

The Witness: That is right.

Mr. Lange: That correction can be made, then?

The Trial Examiner: Yes, sir. We will have the reporter make that correction.

By Mr. Keffer:

Q. You stated, I believe, after the correction was made, considering the Hartley County area, that you considered Potter County 3, Moore County 3, and Moore County 4; is that right?

A. And Hartley.

Q. And Hartley?

A. That is right.

Q. What was the occasion of using all of those on your Hartley County quadrant, Mr. Hammer?

A. Well, it occasionally was, as I mentioned a while ago, that there the isobars indicate a drainage from Hartley County down into Potter County, Quadrant 3. The similarity of the characteristics as nearly as we could tell them, as far as pressures were concerned and the drainage away from the area in Quadrant 3, Moore, and also in Hartley County, for that reason we used the adjacent Quadrants to determine what we considered a fair production per acre pound for Hartley County.

Q. All right, that doesn't apply to Quadrant 4 in Moore County, does it?

A. Well, there is a new development down there that comes up against the corner of Quadrant 4, and in Hartley County in the northeast part of that productive area. There is some new development there and any gas that will move from there does have a bearing on the southwest or would have some bearing on the southwest part of Quadrant 4, Moore County.

Q. Has there been any production from that well?

A. I would have to check on that as I don't remember.

Q. Isn't it your offhand recollection there hasn't been?

A. I would say that that is possibly true, although I wouldn't want to state.

Q. Is that the Phillips Petroleum Company's well that was drilled in there a year or two ago?

A. I would have to check it as I don't remember it.

Q. Let's come back to the map.

A. Yes.

Q. So far as your isobaric lines are concerned, it doesn't indicate any drainage from Hartley County quadrant into Quadrant 3, Moore County, does it?

A. Well, it is difficult to say.

Q. You take the thing we agreed upon. Your drainage patterns are at right angle to the isobar lines?

A. Yes, as a general rule.

Q. And your isobaric lines in there run generally east and west so you get about the same pressure on the west side of Quadrant 3 as you do on the east side of Hartley County quadrant, isn't that correct?

A. That is in general true.

Q. That is exactly what your map shows?

A. Yes.

Q. And if that is not right, your map is wrong, is that the point?

A. Yes.

Q. Come down to the Potter County quadrant. How much drainage do you show out of Hartley County into Potter County? How does it get in Potter County?

A. It comes down, hits a barrier where it can't go on, and it moves in this direction.

Mr. March: Which direction?

The Witness: Southeast along the fault line. You have a lower pressure area down here than you have up there (indicating).

Mr. March: What do you mean?

The Witness: In the north extreme western part of Potter County, Quadrant 3.

By Mr. Keffer:

Q. Of course, it shows your isobaric lines the same, 390 in Potter County and 390 in Hartley County?

A. Yes, and that would mean that gas would migrate.

Q. From 390 to 380?

A. From 420 to 410 and 390. It means there is migration there. It is moving down into this point of Quadrant 3 (indicating).

Q. What part would this well right on the fault line play in that?

Mr. March: Describe it.

Mr. Keffer: It is a well in Hartley County, Block 2, —I can't read the section number—being the only well in Hartley County within an eighth of a mile of the fault line, that is, that is designated on the map.

Q. What effect would that well have?

A. It would have some effect, unquestionably.

Q. But you think some gas would still migrate into Potter County?

A. I think so.

Q. Take up in Quadrant 4, where do you get your drainage—Moore County?

A. I will agree the map in this particular instance shows no drainage from that into quadrant—I mean into Hartley County, or vice versa.

Q. Or vice versa?

A. Yes, but let me point this out: As I explained a while ago, by utilizing an area of original field pressure at 430 pounds, if I included that area I have then had an actual minimum of gas to apply to the Hartley County area.

Q. What do you mean, that you would have a minimum?

A. Well, you can't draw isobars out into territories clear away from where there are producing wells and then include those outside areas. If you include them you are bound to get a minimum production per acre pound, depending upon the size of the area.

Q. Wouldn't it be just the opposite? Wouldn't you get a maximum where you were taking in a quadrant virtually virgin in pressure throughout?

A. No, you are getting back to that remaining reserve per acre.

Q. Yes, possibly so, but tell me why you wouldn't get that.

A. I have already explained it.

Q. Let's try it once more and I can possibly get it.

A. As I explained a while ago, this question of remaining reserves per acre hasn't anything to do with the calculation of the reserve question at all.

Q. Let me approach it in another way: To do so I will assume this: If as a matter of fact Quadrant 3 in Moore County is more productive per acre than Hartley County quadrant then you have increased your production per acre in Hartley County by figuring Quadrant 3, Moore County, into it?

A. Let's see. You say that if Quadrant 3, Moore County, is more productive—

Q. Per acre, than Hartley County quadrant, then when you average Hartley County quadrant in with Quadrant 3, Moore County, you have necessarily increased the calculated acre content in the Hartley County quadrant?

A. No, you are still confusing those remaining reserves.

Mr. Keffer: Let's don't talk about it.

The Witness: That is what we are talking about. I don't propose to have remaining gas reserves confused at all.

Mr. Keffer: We are not confusing them.

The Witness: No, we are not.

Mr. Keffer: That is entirely out of my mind. I don't want you to figure on remaining gas reserves. I want you to figure on original gas reserves. There isn't any need for there to be any confusion unless you deliberately talk about one thing while I am talking about another.

The Witness. I want to get it straight. This remaining reserve per acre in Mcf. is an after thought and it was simply illustrative.

Mr. Keffer: Just forget about it.

The Witness: All right.

Mr. Lange: In order to identify it, you are referring to the remaining reserves per acre as set forth in Exhibit 186?

The Witness: It is also set forth in Exhibit 180.

Mr. Lange: Both of them?

The Witness: Yes.

Mr. Keffer: That is all I am trying to do, just trying to illustrate as you were in the other instance.

The Witness: Suppose we wait until we get the original reserves for the various quadrants before we go into that.

Mr. Keffer: If that is satisfactory to the Examiner it would be satisfactory with me, but I don't like to leave this subject now and come back to it later.

The Trial Examiner: Perhaps we might take a short recess at this time.

Mr. Keffer: I would prefer to do that rather than go into something wholly unrelated and then come back to this at a later time.

The Trial Examiner: We will stand in recess for five minutes.

(At this point a short recess was taken, after which proceedings were resumed as follows:)

The Trial Examiner: The hearing will be in order.

Mr. Keffer: Mr. Examiner, I can proceed for a little while with Mr. Hammer, even though we don't have the information that was requested. However, I can only go to a certain point. It may take until the noon hour to reach that point, I don't know, but I would like to have it understood that if I do get some of these other matters out of the way rather expeditiously, and it isn't quite the noon hour, that I would like to wait until the additional information is available before proceeding further.

The Trial Examiner: Very well, Mr. Keffer. You can go as far as you can and we will recess through the lunch hour. Perhaps the papers that could not be found by Mr. Hammer can be located by him during the lunch hour.

Mr. Spencer: Mr. Lange advises me that he has some other things he could fill in with to facilitate our running until the lunch hour.

The Trial Examiner: Very well.

By Mr. Keffer:

Q. Mr. Hammer, we were discussing primarily the Hartley County quadrant at the time we recessed. Now, I will still have some other more or less general questions regarding your method of computing reserves which I can develop at this time. I will try not to get too much into the question of remaining reserves or original reserves or acre per pound drop until we get that additional information. It may come in at times but I will stay away from it as far as I can until we do get that information. Is that satisfactory?

A. Very well.

Q. Mr. Hammer, when you figured Quadrant 2, Moore County, just what quadrant did you take into account then?

Mr. Lange: Which table in Exhibit 180 are you referring to, Mr. Keffer?

Mr. Keffer: I am referring to the table on the back of Page 5—.

Mr. Lange: Table 3, Page 5?

Mr. Keffer: That is right. I am referring to Moore County No. 3 quadrant.

The Witness: You are referring to Moore County, Quadrant 3?

Mr. Keffer: That is right.

The Witness: Hartley County, Potter 2, Moore 2, Potter 3, Moore 3, Moore 4 and Moore 5.

By Mr. Keffer:

Q. Now, in figuring Quadrant 3, Moore County, you have taken in just one additional quadrant, haven't you, and that is Quadrant 2 in Moore County?

A. One additional—

Q. That is, one additional quadrant in addition to those you did consider while you were figuring the Hartley County quadrant?

A. No, that isn't true. In Hartley County I used Hartley, Potter 3, Moore 3 and Moore 4.

Q. All right.

A. That is 1, 2, 3, 4, 5, in Moore 3—

Q. It is just 4, isn't it?

A. 4, that is right. In Moore 3 I used Hartley, Potter 2, Potter 3, Moore 2, Moore 3, Moore 4 and Moore 5.

Q. Yes, and you added Moore 2 and Moore 5?

A. That is right.

Q. I didn't think you had used Moore 5 but I hadn't checked.

I will ask you again, looking at your isobaric lines and assuming that your gas flows at right angles to your lines, how did you figure that any gas out of Quadrant 3, Moore County, got into Quadrant 5 or vice versa?

A. I didn't figure it, but it did get into Quadrant 3.

Q. How is that?

A. I didn't figure there was any out of Quadrant 3 that got into Quadrant 5.

Q. Or vice versa?

A. Not from Quadrant 3, but from Quadrant 4.

Q. Quadrant 4?

A. In that case the isobars indicate the pressure differential between 4 and 5.

Q. What does that mean?

A. It means probable local migration into Quadrant 5.

Q. But we are not figuring Quadrant 5, we are figuring ~~Quadrant 3.~~

A. All right. What we are doing is balancing it up. Let's get this straight. If I take a quadrant, any one of them where I utilize them in this group and assume that there is more production and more reserve, if I utilize one with a less reserve and I take the total acreage, why, it makes the lesser one greater and the greater one lesser, so you get a balance.

Q. Let's go just a step further. Doesn't your map indicate some drainage out of Quadrant 5, Moore County, into Quadrant 6, Moore County?

A. Very very slight, if any.

Q. All right, doesn't it indicate some drainage out of Quadrant 2, Moore County, into Quadrant 1, Moore County?

A. No.

Q. None at all?

A. No.

Q. Well, what is this isobar here—your 360?

A. That is 380.

Q. 380?

A. Yes.

Q. What is the next lower one, or is that a lower one?

A. That is your 360.

Q. 360?

A. Yes.

Q. Wouldn't gas flow from 380 to 360?

A. All right, here is a 380 again—

Mr. March: Where is that?

The Witness: Quadrant 1. It is in the western part of Quadrant 1.

By Mr. Keffer:

Q. Take the big area south of that high you might have there, what do you have then?

A. There is nothing there to indicate any drainage from 2 to 1.

Q. We have in your first isobaric line near the east central part—your isobaric line is in the east central part of Quadrant 2, 380 pounds contour line, directly east of that, and in Quadrant 1 we have a 360-pound line—

A. Yes and here we have 380 pounds.

Mr. March: Where is that?

The Witness: In the western part of Quadrant 1 you have an equal pressure here (indicating). You don't have a decline here (indicating). If there were any particular drainage at that point it would be north but the distance here (indicating) is so great—the pressure is an equal pressure—but you don't have over five pounds differential; until you get over here it doesn't amount to anything. Here you would have ten pounds but it is all close together, but over in Quadrant 1, Moore County—

By Mr. Keffer:

Q. You have 20 instead of 10?

A. No, these are ten isobars (indicating).

Q. I thought you said 360.

A. This is 360 and this is 380 (indicating).

Q. You outline the higher pressure which we have been referring to north of the drainage area we have been speaking—a little north of the drainage you have been speaking of as having no influence on it at all?

A. What pressure are you referring to?

Q. The one you have been referring to.

A. Certainly it has a distinct bearing. Gas won't flow against a pressure that is higher.

Q. I am talking about the flow from 380 to 370, Mr. Hammer What is that pressure up there?

A. This is a 370 instead of a 380. It is this isobar that cuts the end of the northeast corner of Quadrant 2, goes into Quadrant 1, Moore County, and extends in a general southeasterly direction across the quadrant. That is a 70 and not an 80.

Q. What is that—an 80? Where do you get your 80 on there?

A. Well, it is from the pressure on that well there.

There is a well here in Section 46, T & N O Survey, Block 16, that has a pressure of—as I read it on this map here it is 380. You would then have a 380 isobar between those two wells.

Q. You show that as a very localized condition, don't you?

A. Well, it covers quite a little area.

Q. It covers a little more than a Section, say a thousand acres at the outside?

A. All right.

Q. That is a very little estimate, isn't it?

A. You made the estimate.

Q. I am talking about an area about a mile or two south of that, south of even where you have your lines drawn. Let's stay with that area down there.

A. All right. You were talking about the distance east, weren't you?

Q. No.

A. You mean the distance over here from—

Q. I am mentioning the differences between pressures—

A. All right, I know you are.

Q. Go ahead.

A. But here you have 1, 2, 3, 4 miles, and in that four miles you only have a difference of pressure in the amount of ten pounds. If through four miles of the character of material of which that is composed—

Q. What is the character of the material?

A. I don't think anybody knows, but we do know they—

Q. All right, go ahead.

A. We know the permeability varies to beat the band. Over an area of four miles with a ten-pound differential you wouldn't have very much drainage, if any.

Q. How do you know you wouldn't?

A. It is just common sense.

Q. You don't even know the kind of material it is going through, yet you say there wouldn't be any drainage?

A. We do know the whole formation has variable characteristics both as to permeability and as to porosity.

Q. Certainly. There isn't any question about that, but you don't know the kind of formation you have there or any other place in the field, do you?

A. I do know if you only have a 10-pound differential in four miles you are not apt to have very much drainage.

Q. Let's take a pipe line with ten pounds differential. Would gas go through that line?

A. There isn't any comparison—

Q. Answer my question.

A. A pipe line is an open tube without any restrictions in it, and here you have an infinite number of pores.

Q. How do you know you have?

A. It is characteristic of all formations.

Q. Well, some are more permeable than others, aren't they?

A. What?

Q. Some are more permeable than others, aren't they?

A. Well, yes, naturally.

Q. You paid no attention to the permeability?

A. The fact remains you can't make a comparison as between any underground formations in a pipe line.

Q. Again you have stated here, and you stated yesterday a number of times you knew nothing about the formations and made no particular study of porosity or permeability?

Mr. March: He never stated that

The Witness: I never said that.

Mr. Keffer: Let the witness answer the question.

The Witness: I said I made no study of porosity or permeability.

Mr. Keffer: We will limit it to porosity or permeability.

The Witness: That is right.

By Mr. Keffer:

Q. Then you don't know what the porosity is across the four miles and what the permeability is across the four miles?

A. It really doesn't make any difference. Any geologist who knows anything at all about production horizons knows that in four miles with only a 10-pound differential in pressure between the two points that you are not apt to have any appreciable movement.

Q. You are now hedging on me a little. Go ahead.

A. That is all.

Q. Oh, that is all? You could have a highly porous and highly permeable situation there and you would have a substantial movement of gas with a 10-pound differential, wouldn't you?

A. No, not necessarily.

Q. That is your answer?

A. Yes, that is my answer.

Q. We will let it stand.

Now, Mr. Hammer, getting back to where we were before recess—during recess I got off of the thing I hadn't completed on the Hartley County area—I believe you admitted that while we were on that, as far as your map disclosed, there wasn't any drainage from Hartley County into Moore County Quadrant 4, or vice versa?

A. I think that is true.

Q. Yet you did use Moore County Quadrant 4 in figuring out Hartley County?

A. Yes, and by using it I gave a lesser reserve to Hartley County Quadrant 1 than if I hadn't used it.

Q. You have some pressure drops in Hartley County, didn't you?

A. Yes, some.

Q. You had over 80 per cent or more of Moore County Quadrant 4 where you didn't show any appreciable drop?

A. That is right.

Q. When you averaged those high pressure areas of Quadrant 4 in Moore County with your lower pressure area in your Hartley County quadrant, now as a matter of fact, didn't that give you a higher pressure over the two quadrants than you had originally in Hartley County?

A. No, not—it gave you a higher pressure but it didn't give you a higher production per acre pound; it gave you a smaller one.

Q. It gave you a smaller production per acre pound, that may be true, if you take the same volume of gas and increase your acreage. That would be inevitable, wouldn't it?

A. Yes. The point I am trying to make is that it gives you a minimum reserve.

Q. What does it do to Quadrant 4?

A. Well, it also gives that—when you calculate that thing out it gives it a minimum reserve.

Q. What does it do to all the rest of them?
A. The point I made a minute ago—
Q. Answer my question, please.
A. I am going to answer it.
Q. All right.
A. If you take an area of larger size and take the gas from it alone and apply the gas removed from it to a larger area—larger acreage, and particularly to an acreage where you have no indicated decline at all, then you are going to very materially decrease the production per acre pound decline.
Q. Now, if those additional acres that you would add were not very productive acres, and you added it in with this acreage down here in Quadrant 4 and then you averaged them out, don't you get a distorted figure in both quadrants?
A. No, not particularly, because I am averaging the principal—
Q. You are just averaging, is that all you are doing?
A. No, grouping.
Q. What is the difference between grouping as you do it here and averaging?
A. Call it averaging if you want to. I won't argue with you.
Q. Isn't that what it is? If it isn't averaging, I don't want you to say it.
A. It is a utilization of a quadrant and those immediately adjacent to it to determine the average production per acre pound for the area and then applying it to the area in question.
Q. All right. Now, when you took that Hartley County quadrant and you averaged all of those other quadrants in here that you talked about, you had a calculated per acre pound decline of 34.43 pounds, didn't you?
A. That is right.
Q. In all of the quadrants that you figured?
A. Yes, for the group.
Q. And you added to that one in Hartley quadrant and you had the same figure in Moore County 3, didn't you?
A. For the entire group used.
Q. And Potter County 3 and Moore County 4?
A. All right.

Q. You had that 34.43 pounds?
A. That is right.
Q. Then when you came down to figure Potter County 3, what did you get when you figured that one again?
A. 35.1.
Q. This time you got 35.1 in Quadrant 3, the other time 34.3—
A. Wait a minute. The 34.43 was the grouping for the entire area.
Q. And that is a part of the area?
A. Yes, but I did not when I arrived at the production per acre pound for Quadrant 3, Potter County, use the quadrants I used in the determination of it for Hartley County.
Q. And you got a different value for Quadrant 3?
A. Yes, because I eliminated the one adjacent to it.
Q. Certainly, there is no question about it.

Now, when you figured Quadrant 3 in Potter County, you took Quadrant 2 in Potter County into account?

A. That is right.
Q. And for the area, which included Quadrant 2, you got 35.1 pounds, didn't you?
A. Quadrant 2, Potter County?
Q. Yes.
A. When I calculated the area for Potter Quadrant 2?
Q. No, when you were figuring on Quadrant 3 you got 35.1 pounds in Potter County 2 because it was part of the area you figured—
A. Taking in the whole area?
Q. That is right.
A. That is right.
Q. You got 35.1. Well, what did you get in Quadrant 2 when you figured it?
A. Well, the whole point is that I did not—
Q. Answer my question, please.
A. I am answering your question.
Q. No, you're not.
A. I am, too.
Q. Just give me the pounds you got.

The Trial Examiner: Give him the pounds, Mr. Hammer.

The Witness: All right.

Mr. March: He can make any explanation he wants to.

Mr. Keffer: That's all right, let him answer my question

The Witness: You wanted to know in Potter 2?

By Mr. Keffer:

Q. That's right.

A. All right. 42.71.

Q. The other time you figured it you got 35.1, when you figured it the other time?

A. No, you can't compare the two, because I used different acreage.

Q. Let me ask you another question: When you were determining the per pound drop in Quadrant 3 you determined Quadrant 2?

A. That's right.

Q. And over the whole area including Quadrant 2, you got 35.1 pounds?

A. That's right.

Q. Then when you came over to Quadrant 2 and took in a little different area, then you got on Quadrant 2, 42. plus pounds?

A. That's right.

Q. When you figured Quadrant 2 you took in Quadrant 1 in Potter County, didn't you?

A. That's right.

Q. You necessarily got 42 plus something in Quadrant 1 in the whole area, didn't you?

A. Not in Quadrant 1 in the whole area

Q. All right, when you came down and figured Quadrant 1 together with other acreage, what did you get?

A. Quadrant 1 which?

Q. Potter County.

A. 58.97.

Q. 58.97. All right, you get a different answer every time you make a different calculation in each quadrant, don't you?

A. That is because—it is easily explained. We are making a progressive determination eliminating areas that aren't adjacent to the areas. When you take in new areas with different characteristics you are bound to take—you are bound to get new answers.

Q. And you do get new answers for every Quadrant every time you make an additional calculation?

A. No, that isn't true at all.

Q. Let's run through.

A. All right.

Q. All right. Take Quadrant 2 in Moore County. When you figured it in with Quadrant 3, you got—Moore County—you got on it 34.58 pounds, didn't you?

A. You are talking about what—Moore 3?

Q. I am talking about Moore 2.

A. Moore 2.

Q. When you figured it in with Moore 3 you got a weighted average of 34.58 pounds per acre pound drop?

A. Well, you are talking about Moore 3.

Q. No, I'm talking about Moore 2. When you figured it in with Moore 3.

A. You have got the wrong figure. It is in the column above. Moore 2 is above 3.

Q. Oh, we'll go through the whole thing again. When you were determining the remaining reserves as you have it here on this map of Quadrant 3 in Moore County, you included among other quadrants, Quadrant 2 in Moore County, didn't you?

A. That's right.

Q. All right, now, you figured, then, the acre pound drop for the area which included Quadrant 2, Moore County, 30.58 pounds, didn't you?

A. In arriving at a production per acre pound for Quadrant 3.

Q. That's right. You included Quadrant 2 and got 30.58 for the whole area?

A. That's right.

Q. Then when you came down to figure Quadrant 2, you had a little different area. What did you get then for Quadrant 2, Moore County?

A. Under the group determination I got 36.82.

Q. 36.82. You got still a *differn* figure.

A. Sure.

Q. All right, now, let's come back to Hartley County. When you figured it out the first time you got 34.43, didn't you?

A. Using the group.

Q. By using the group, that's right. When you made a separate calculation on Quadrant 3, Moore County, it included Hartley County, didn't it?

A. Yes.

Q. That time you got 36.58, didn't you?

A. For the entire group, yes.

Q. For the entire group which included Hartley County?

A. That's right.

Q. So now you have got two figures depending on which way you figure it in Hartley County, haven't we?

A. No, we haven't.

Q. Well, we had 34.43 one time and I believe 30.58 another time, different figures.

A. You are confusing the group production per acre pound as determined as against the production per acre pound utilized in determining the reserves of a particular part of that group.

Q. Here is what I am doing, and see if this is not a fair statement, Mr. Hammer:

I go out with you and I tell you that I want to buy all of the acreage in Quadrant 3, Moore County, Texas, and I want you to tell me the value of it. You go ahead and figure that value out and you get it predicated upon 35.58 pounds, per acre drop in pressure and you figure back your reserves from that.

Mr. March: Now, just a minute, Mr. Keffer.

Mr. Keffer: Let him answer. Wait until he answers and then you can talk all you want to.

The Witness: That's right.

By Mr. Keffer:

Q. All right, then you get that 30.58 that we just referred to.

A. That's right.

Q. All right, I'll ask you, Mr. Hammer, how you got that—well, you say that the average of all those surrounding quadrants—well, I have got that. Then I decide I will buy Quadrant 2. Now, you gave me a figure which is 30.58 for all the quadrants, average, and I go out to buy Quadrant 2 on that and I will get into a mess, won't I?

A. No, you won't, not if you are employing me you won't.

Q. All right, now, go ahead.

A. I will eliminate Hartley entirely when I get over to Quadrant 2 and I will utilize the surrounding areas to find out what the proper figure for that is, and naturally I will get another figure because I am using different data.

Q. All right. Suppose I want to buy Hartley County, Moore 3, Potter 3, how do you do that?

A. Just as I did in this estimate.

Q. Would you just eliminate those outside lines of those quadrants?

A. I haven't done it in any case.

Q. Suppose I wanted to buy all those surrounding quadrants how would you figure that?

A. Buy all the surrounding quadrants?

Q. Yes, together—the whole works, I want to buy all of Moore and Hartley and Potter County.

A. Well, just by the method used I would give you the reserve.

Q. Slip over and take these adjoining ones in Hutchinson County and Carson County.

A. That's right.

Q. Supposing I wanted to buy those two, then how would you figure it?

A. Well, if you wanted to buy the whole field—

Q. I haven't got enough money quite yet to buy the whole field.

A. I would figure the same just as I have figured this thing. Naturally, as I have stated a while ago, we used a process of eliminating and we followed that thing clear through the field from end to end.

Q. Yes.

A. All right. That ought to explain it.

Q. Well, if you will answer my question, maybe that will explain it to me better. If I wanted to buy all of Moore and Potter Counties plus the adjacent quadrants in Carson and Hutchinson County, how would you figure it? You would take the eastern quadrants in Hutchinson and Moore County and figure them all in?

A. That's right.

Q. You go right down the line until you have covered the whole field?

A. Why, certainly, I have just said that.

Q. All right, then, you have got a fieldwide figure in effect, or figured the field in whole in effect when you considered Canadian River, didn't you?

A. No, I didn't have to at all. I will tell you why I didn't have to. I considered—

Mr. March: Where is that?

The Witness: Now, wait a minute. I considered Quadrant 3 in Carson County. Now, there is nothing there on that map or any map over a five-year period that indicates any possibility of any drainage eastward from Quadrant 4 over into Quadrant 2 in Carson County. Therefore, utilized Quadrant 3 and grouped it around Quadrant 4 in Carson County and there was no need of going any further east than that. That gave me all of the data I needed to calculate your reserves.

Q. All right, now, let me see, Mr. Hammer. You say you figured Carson 3, Quadrant 3, Carson County, in with Quadrant 4, Carson County?

A. That's right.

Q. And you got a weight for Quadrant 3 and Quadrant 4 and those others that you might have considered, didn't you?

A. Yes.

Q. As applying to all of them?

A. Or the group around that.

Q. All right, now, just take that just a step further. Quadrant 3 at the very time you were making that calculation had been losing gas by drainage to Quadrant 2, Carson County, hadn't it?

A. Well, yes, probably, but very little.

Q. Well, but it had been losing some by drainage?

A. So small a part in relation to the whole, it would be insignificant.

Q. How do you know it is small?

A. Well, take the area—come over here in the eastern part of 3 and the configuration of isobars there show that your drainage will go straight north. Now, when you get over to the east in the last two sections you might have some slight drainage, but it is so small it is insignificant.

Q. How about this part (indicating)?

A. That is not—it doesn't affect it at all.
Q. Why doesn't it?
A. Well, look at the isobar.
Q. What is that number?
A. Well, that is—
Q. No. 370.
A. 370.
Q. That is the next one northeast.
A. 360.
Q. All right, why isn't there drainage from 370 to 360?
A. I didn't say there was none. I said very very small, if any.
Q. You said there was none at all in the south part, that what little there was up in the east central part.
A. Well, that is a relative term, but I stated that there is nothing in that picture or any picture over a five-year period that indicates any appreciable drainage at all except possibly along the extreme eastern edge.
Q. What is the permeability and the formations there?
A. The same as any other.
Q. Then it is common over the field?
A. I don't know the permeability nor neither do you or anybody else, nor do I know the porosity.
Q. All right, now, when you figured Quadrant 3, what did you take into consideration in Carson County, Mr. Hammer?

The Trial Examiner: You mean what quadrants?

Mr. Keffer: Yes, what quadrants?

The Witness: Those immediately surrounding.

By Mr. Keffer:

Q. All right, then you did take into account quadrant 2, didn't you?
A. That's right.
Q. There was no drainage, you say. Then, why did you do that? Why was there necessity to do that?
A. Well, I said there was some slight drainage, yes.
Q. But you said a while ago there wasn't enough to make any difference when figuring back west, but when figuring east it makes a lot of difference, is that your point?
A. No.

Q. All right, state it.

A. My position is that in Quadrant 3, Carson County, over a five-year period there is nothing to indicate any drainage—I mean the configuration of the isobars are such that you would have no drainage from Carson 3 into Carson 2 except along the eastern portion, and it would be small.

Q. But you did figure that it was enough drainage in computing Quadrant 3, don't you think you ought to consider also Quadrant 2?

A. Yes, that's right.

Q. All right. Now just drive a peg there and hold it there a moment, but when you are figuring Quadrant 4 to the west you took in Quadrant 3 in getting your composite figure for all of the quadrants considered, but you gave no consideration to Quadrant 2, Carson County. Now, isn't that right?

A. I think that is right, and the reason for it is that as I have stated here three times in succession and I will state it a fourth—

Q. All right, I am asking you.

A. That any drainage of Quadrant 3 into Quadrant 2, Carson County, would be such a minimum amount, based upon an opinion of the five years of isobars, that it would be insignificant as far as anything affecting Quadrant 4 is concerned in Carson County.

Q. Now let's get Quadrant 2, Carson County, that has affected Quadrant 3 of Carson County, else you wouldn't have used it when you were computing Quadrant 3, would you?

A. It had some effect on Quadrant 3.

Q. All right, now, the effect, whatever it had—whether it was great or little—was not taken into account when you figured Quadrant 4 and weighted Quadrant 3 into it.

A. Well, there might be a slight—there would be possibly a slight amount there but it would be so small it would be insignificant.

Q. "Might be"—isn't it postive that it is? Is there any question about it?

A. I say, if it is, it is so small that it is insignificant.

Q. All right, you do admit there was an error in that respect?

A. Well, I recall it.

Q. That is where a matter of judgment came in?

A. That's right.

Q. The other day you said judgment didn't come into this.

A. I said I used the same judgment in minor instances. Let's go a little further on this thing, Mr. Keffer.

Q. All right.

A. I previously stated that we balanced these things out clear across, using adjacent quadrants. I presume that if I continued on to balance those things clear on out over here into Wheeler County that you would say that it had an effect on your reserve over here?

Q. Well, wouldn't it?

A. No, not at all. I might just as well explain that now as any other time.

Q. That's right.

A. The Texas Railroad Commission itself and I think most of the geologists that have done any work in the field recognize the fact that here in the vicinity of Lefors in Gray County they make a separation between the fields. They call—the Texas Railroad Commission always refers to that as the east sweet field, and they refer to this on this side as the west sweet and the west sour field, so when you get beyond that point in there some place, all of the rest of that from the vicinity of Lefors on east is the eastern field.

I take this position: The reason why that is done is that there is no chance at all in the opinion of the Texas Railroad Commission of any direct connection between the east field and the west field.

Q. What do you mean, "any direct connection"?

A. Well, as far as any gas movement is concerned.

Q. There is a direct connection?

A. Well, as far as any gas movement is concerned, that is the reason the Texas Railroad Commission did it.

Q. What do you mean by the opinion of the Texas Railroad Commission?

A. Well they established the line.

Q. Can you quote anything that they ever said in writing?

A. No.

Q. Did you ever see anything anywhere that they made the statement you just made?

A. I have taked with their engineers and other folks too. I don't know that they have published it, but the fact remains that they did it.

Q. Don't you know the facts why they cut that off and called that the east field and the west field?

A. Well, just as I stated.

Q. Do you know when it happened?

A. I know that in the opinion—in my opinion and in the opinion of lots of folks I have talked to, as far as any economical consideration is concerned there is no likelihood of any gas moving from that eastern part of the field that would affect anything in an economic sense in the western part of the field.

Q. All right, let me state it this way: Do you know that that east part of that field was cut off—I say, "cut off" —was considered separately from the standpoint of proration only and that was the only reason for it?

A. Well, I don't know that, no.

Q. You don't, and do you know that tracts, and do you know that tracts in the eastern counties usually are small, a lot of 160-acre tracts and 160-acre leases, that the tracts and leases are bigger in the west field and the Commission wanted to zone the field so as to establish a different spacing rule in Wheeler County in the east field than what they had in the west field? Don't you know that to be a fact?

A. I don't know what their opinion was. I do know that the acreage in Wheeler County is in smaller farms—in smaller areas.

Q. All right, do you—you do know that in every published report that you ever saw concerning the Panhandle field, included Wheeler County wells along with the rest of the field, didn't it?

A. Yes, but the Texas Railroad Commission's reports always referred to it as the east and west field.

Q. In giving the weighted pressures for the Panhandle field, does the Texas Railroad Commission take Wheeler County into account?

A. Yes, I believe it does.

Q. Therefore, the Railroad Commission considers it all one reservoir and considers the pressures in Wheeler County have something to do with the pressures in the rest of the field, is that not correct?

A. Well, you will have to get that from the Railroad Commission.

Q. All right, we'll go back. You got a lot of things from the Railroad Commission and I thought maybe you got that, too. They do in weighting out pressures for the field consider the whole field in giving the weighted pressure for the Panhandle field?

A. I believe that is true.

Q. All right, now, Mr. Hammer, you might have to draw on your imagination to say that a cubic foot of gas—a small particle of gas—that started moving out here in Hartley County would end up over here in Wheeler County? Now, that is the point you were trying to make a while ago.

A. The point I was trying to make?

Q. Yes. It would just get lost before it got to Wheeler County, or just get tired moving and stop before it got that far.

A. Well, it would probably meet one of these hypothetical barrier or actual barriers you set up yesterday, and couldn't go any further.

Q. I am going to agree with you. I am not a geologist, bear in mind. It would be unreasonable to expect a minute volume of gas like—say a drop of gas—that isn't a very good word, but we will say a cubic foot of gas—that started over here in the tip of the field over in Hartley County would finally be produced out of a well in Shamrock over in Wheeler County?

A. That would be true.

Q. That would be too much to expect?

A. That is true, and it would be equally true if you had an infinity of those little particles.

Q. All right, but when a movement starts over here, you get a low pressure area and it draws from the higher pressure area in the west of it, doesn't it?

A. No, only locally.

Q. All right, let's get our stock illustration. We can go better at Borger. You have a low pressure area at Borger, haven't you?

A. Yes.

Q. It takes from the next higher pressure to the southwest?

A. And to the northwest and southeast.

Q. But it does come from the southwest?

A. Yes, and from the others too.

Q. All right, when it takes from the southwest it reduces the pressure in that band, doesn't it?

A. Now, let's see if I get what you mean. I am not sure —you talk about bands—

Q. I am talking about a pressure band, the bands between your contour lines—isobar lines.

A. Repeat that question.

(The question referred to was read by the reporter, as set forth above.)

By Mr. Keffer:

Q. The next higher band.

A. Yes, that is the natural thing.

Q. All right, then, what happens to that next higher band? The pressure has become lower and it takes some gas from the next higher band, doesn't it?

A. That is where the pressure always comes from.

Q. All right, that band becomes lower and it takes some gas from the next higher band, doesn't it?

A. That is a natural assumption.

Q. That band becomes lower and it takes some gas from the next higher band, doesn't it?

A. Qualifiedly, yes.

Q. What is the qualification?

A. You reach the point after while where, as your isobars get farther and farther apart on any given map, it becomes less and less and less all the time.

Q. All right, we'll come to that in a moment. Those things do exist.

A. Oh, yes, they do exist.

Q. All right, by reason of the low pressure in Borger you would have a displacement of gas back in the Canadian River reserves without the necessity of gas actually starting its movement in the Canadian River reserves and actually ending up over at Borger, wouldn't you?

A. What is the point of Canadian River area—reserves your are talking about?

Q. Any part of it.

A. Oh, that is not true.

Q. All right. what's wrong with it?

A. Well, I think it is just about time to get some facts in here.

Q. I do, too. Go ahead.

A. Now, Mr. Examiner, Mr. Keffer has been laying great stress on—

Mr. Spencer: Wait a minute.

The Witness: —on Quadrant 3 in Hutchinson County.

Mr. Spencer: I thought maybe the witness was going to make an argument to the Examiner.

The Witness: I want to point out the reason for my statement.

Mr. Spencer: All right.

The Trial Examiner: Let me say this, Mr. Hammer, you must remember that Commission's counsel will take you back on redirect. Now, if what you are about to say is an explanation of what you have been asked on cross examination, why, perhaps you should go ahead, but if not I think we would move along much faster—

The Witness: Well, then, I think we better leave it for redirect, then, Mr. Examiner.

Mr. March: Mr. Hammer, your statements aren't complete, though, unless you make this explanation.

The Witness: That is true.

Mr. March: I think in that sense, Mr. Examiner, it is very definitely a statement which the witness wishes to make in explanation of his answers to Mr. Keffer's previous questions.

The Trial Examiner: In that situation it is perfectly all right, but I thought we might hurry this thing along a little.

Mr. Keffer: All right, if Mr. March or Mr. Lange wants to take the witness on that subject and let us have him back, why, all right. You can have your redirect now on that particular phase of it, if you want to get that in.

Mr. March: I wouldn't want to interrupt your cross examination.

Mr. Keffner: That's all right, you go right ahead.

Redirect Examination.

By Mr. March:

Q. You may make the explanation you had in mind.

Mr. Keffer: Well, that's just the same as though we had gone ahead in the first place, Mr. March. I thought you wanted to cross examine.

Mr. March: Do you want me to ask a whole bunch of little questions?

The Trial Examiner: Well, let's go ahead, Mr. Keffer, and bear this in mind, Mr. Hammer, that if you have an explanation to make, you can make that explanation, but this matter of volunteering information, I just want to call your attention to the fact that Commission's counsel will take you back on redirect and I am sure they will not overlook any of these matters.

The Witness: I think it would be better to have it that way.

The Trial Examiner: I think we will get along better.

Mr. Keffer: We really would make time, Mr. Hammer, and Mr. Examiner. There is no question about that.

Mr. March: However, Mr. Examiner, the witness can always feel free to make any explanation of his answers if he sees fit.

The Trial Examiner: That's just what I have advised him, Mr. March.

Mr. Keffer: We have always been very cooperative, I think, in allowing witnesses to make explanations when so desired.

Recross Examination (Continued)

By Mr. Keffer:

Q. All right, Mr. Hammer, you made a statement a while ago that where your isobar lines were wide and there wasn't much differential in pressure that there wasn't much migration of gas, didn't you?

A. Over long distances that is true.

Q. Well, if the isobar lines are wide apart, that follows, doesn't it?

A. What follows? What do you mean?

Q. That they are a greater distance apart than when they are close together.

A. That's right.

Q. All right, now, that depends on porosity and permeability of your formation, doesn't it, entirely?

A. Yes, on the two factors.

Q. That's right, and you don't know what either one of them is—you have said that?

A. No, I don't.

Q. And you don't know where—you don't know whether the gas migrates rapidly or not at all in that area that you just spoke about, do you?

A. Well, the question of the rate of gas migration is a rather intricate problem.

Q. I grant you that, but you made a positive statement a while ago that it did not do a certain thing.

A. What statement?

Q. That there was no appreciable migration of gas where your isobar lines were wide as between 10-pound intervals.

A. Well, that was on the basis that your pressure differential is so small, when you consider distance, that under any ordinary conceivable condition you wouldn't have.

Q. That's right. You have admitted that if you have the porosity and the permeability you are going to get the drainage even if there is a small pressure differential?

A. That is also a relative proposition.

Q. Certainly, and you have no idea what either one of them are, either porosity or permeability, and not knowing either of them you make the positive statement that you just know that drainage doesn't occur?

A. Well, I know it, Mr. Keffer, from a configuration of a study of the isobars over a period of five years. Now, we have agreed that when that occurs it usually occurs at right angles, generally, to the horizontal position of the isobar lines themselves. Over a period of our study of the thing there is nothing to indicate in this particular case any longer period or continuous period of migration except the possi-

bility of it just along the eastern line of Quadrant 3 in Carson County over to Quadrant 2 in Carson County.

Q. All right, then it is your position that the configuration of your isobar lines indicate to you that the drainage matter is just now hitting Canadian River?

A. Why, Canadian River hasn't any acreage over in there.

Q. In Carson County—

A. In Quadrant 2 and 3, Carson County.

Q. Well, I am—no, not in 2 and 3, that's quite right. We were over at Borger a while ago, coming back towards Canadian River and I thought that we were yet. I hadn't left that area yet. Let's get back to the Canadian River area. That's what we are talking about. We left the other long ago.

There is drainage from Canadian River to the northeastward. There can't be any question about it on your isobar lines, can there?

A. Well, they indicate a lower pressure in that direction, certainly.

Q. The gas travels from high pressure to low pressure areas, doesn't it?

A. That again is a relative proposition.

Q. Did you ever know it to fail to do it?

A. Well, but the rate is a relative proposition.

Q. All right, the rate depends upon porosity and permeability and pressure differential, doesn't it?

A. That's right.

Q. You know what pressure differential is; you haven't any idea as to permeability or porosity?

A. No.

Q. You have only one of the three things you must know to determine that, haven't you?

A. Well, I think that question will be answered later.

Q. Why not answer it now?

A. Well, because I would just request to come back here and reserve a statement.

Q. Do what?

A. Reserve a statement.

Q. What do you mean by reserve a statement?

A. Well, the Examiner himself suggested that I reserve a statement—

Mr. Keffer: I don't quite—

The Trial Examiner: You understand at that time, Mr. Hammer, I qualified that to the extent that I thought it would be best for you not to volunteer information which Mr. Keffer had not inquired on; that is, on matters on which Mr. Keffer had not inquired, but he is getting down to it now.

The Witness: No, that's just the point, he hasn't got down to it.

Mr. Keffer: Read the question.

(The question referred to was read by the reporter, as set forth above.)

The Witness: Except certain definite facts, aside from the question of permeability or pressure.

By Mr. Keffer:

Q. All right, what are those certain definite facts?
A. That's the thing I was going to do a while ago and I will do it now.
Mr. March: He may mention them now.
By Mr. Keffer:
Q. All right, go right ahead.
A. Now, the facts of the case are, and we have agreed on it, that—
Q. Who—you and me?
A. You and I.
Q All right.
A. —that the Borger area was originally discovered around the fall of 1925 and the active development started in 1926.
Q. That is true, we are agreed.
A. And that it continued and spread out from that point, that it was a big prolific field. We admit that during that time there was a lot of wastage of gas. We have had no argument on that. We also agreed that because of that wastage and subsequent withdrawals there had been a low pressure area developed.

Now, we have agreed on that. There is no argument about that.

Q. That's right.

A. But here is something that is very important, and that is this: Notwithstanding the fact that that low pressure area was in existence there, starting in 1926—well, I wouldn't want to say what year—it reached its maximum, but for many years it has existed there as a low pressure area and notwithstanding that fact, right here in your Quadrant 1 in Potter County in 1935 you still had a weighted average pressure in that quadrant of 419.8 pounds, and also in 1939 as of August, 1939, you still had a weighted average pressure for that quadrant of 402 pounds, a drop as between 1935 and 1939 in weighted pressure of only 17 pounds, or an average annual drop of 3.4 pounds.

Now, from 1922 when Canadian River first started to take gas—

Q. Canadian River? No, they didn't start then.

A. Well, Amarillo Oil Company.

At least, regardless of the company, when gas first started to be taken out of there, naturally I think we will all agree that the pressure was 430 pounds. Now, by 1935, or from 1922 to 1935, there had only been a pressure drop—I am talking about weighted pressure now all the time—of 10.2 pounds over a period of 13 years, or an annual drop of 0.78 pounds per year—7/10ths of a pound, from the beginning up to 1935.

Now, from 1922 to 1939 and taking your original field pressure at 430 pounds, there had been only a total drop in weighted pressure from field original pressure to 1939 of 27.2 pounds, for a period of 17 years, or an average of 1.6 pounds per year.

Now we'll take the same general condition for Hutchinson, Quadrant 3. We can't start in 1922 because we have to start at the period of development and for the purpose the tabulation I have just used 1926 because that is virtually when it started. In Hutchinson 3, Quadrant 3, the original pressure we'll say before the discovery well was 430 pounds. In 1935 the weighted pressure was 295 pounds, a difference in

pressure of 1935 pounds over a period of 9 years, or an average annual decline in weighted pressure of 15 pounds.

Now, between 1926 and 1939, assuming the original field pressure at 430 and the terminal areal pressure—or the areal pressure, weighted pressure for 1939 at 270.6 pounds.

Q. Where?

A. We are talking now about Hutchinson, Quadrant 3—or a difference of 159.4 pounds in weighted pressure over a period of 13 years, or an average annual decline in weighted pressure of 12.26 pounds.

Now we will take the same period that we took in the other one, I mean that we took in reference to the other one. We utilized the 1935 to 1939 data. In 1935 the weighted areal pressure for Quadrant 3, Hutchinson County, was 270.6 pounds—no, I beg your pardon. The weighted pressure for 1935 was 295 pounds and the weighted pressure for 1939 was 270.6 pounds, or a decline of 24 pounds over a period of five years, or a decline of 4.9 pounds average over a period of five years.

Now, the point there is, and the reason the tabulations have been made is that notwithstanding that we have agreed and know there is a low pressure area that has continued to exist there and that is still there, that over the period from the beginning of the field up to 1939 it had had no appreciable effect whatsoever on the decline in weighted pressure for the area in Potter Quadrant 1

Q. Is that all of your statement?

A. That's right.

Q. All right. Now, you were talking about what quadrant in Hutchinson county?

A. 3.

Q. 3. You didn't take Quadrant 2 in Hutchison County, did you?

A. No, not in this case.

Q. No, that's right. What do your isobar lines show with respect to Quadrant 3 in Hutchison County?

A. Well, it shows that the pressure is toward the low pressure area.

Q. That's right, that it is losing some gas into the Borger area, isn't it?

A. No, not over the five-year period that we studied.

Q. Well, what would you get right up that way?

A. That's what I pointed out the other day, that between the Borger field proper and Sanford area over here, that area in between those two, the pressure has remained practically at a constant—yes, the pressure isobars have remained almost constant over a five-year period.

Q. Well, what's that?

A. And the drainage—

Mr. March: When you say "what's that?" what do you mean, Mr. Keffer?

Mr. Keffer: He knows.

Mr. March: I know, but the record won't show it.

Mr. Keffer: I know, but I didn't want it to show. I was calling Mr. Hammer's attention to a matter which he had overlooked and I didn't want to embarrass him by putting it in the record. Now since you have brought it out in the open I will state that I was pointing to the very definite drainage from Quadrant 3 in Hutchinson to Quadrant 2 in Hutchinson County, and Mr. Hammer just said there was none and that the reason—

The Witness: Did I say there was none whatsoever?

Mr. Keffer: I understood you to.

The Witness: What does the record show?

(The record referred to was read by the reporter as set forth above.)

By Mr. Keffer:

Q. Well, that is indicating drainage in Quadrant 3 into Quadrant 2 in Hutchinson County, was it not?

A. Indicating the position of the isobars.

Q. Well, then, the position of the isobars indicated drainage, did it not, as I have just stated?

A. The position of the isobars do indicate drainage but the position of isobars do not always indicate drainage over any large distance, and in this case it is true there are wells between two indicated points that they themselves are taking gas out of the reservoir. Because you happen to have

an indicated decline in isobars or pressures doesn't necessarily mean that that gas is all migrating across. These wells intervening always get their share of the gas and are largely responsible for the pressure decline.

Q. How do you know they are largely responsible?

A. Well, they take out a lot of gas.

Q. That's right, but how much more gas is passing through?

A. Well, in an intensely drilled area such as that Borger area there isn't a great deal of chance of long distance migration.

Q. Well, what determines how much gas is passing through?

A. Well, that is indeterminable.

Q. No, what are the factors that cause it to pass through and influence the rate?

A. Well, we have repeated that so many times.

Q. One more time, please.

A. It is always a pressure differential, of course—

Q. Pressure differential, porosity and permeability, isn't it?

A. Yes, relatively speaking, yes.

Q. All right, under here you have a pressure differential here, haven't you (indicating)?

A. Where are you talking about?

Q. The southeast part of Quadrant 3 in Hutchinson County and the southwest part of Quadrant 2 in Hutchinson County.

A. Yes, the isobars are relatively close together there.

Q. All right, then, what do you say about your permeability, then, and porosity? You don't know, do you?

A. I do say this, though.

Q. Answer my question first. Do you know what the porosity and permeability is there?

A. I don't and neither does anybody else.

Q. All right, and you made no effort to find out?

A. No.

Q. All right, go ahead.

A. But as far as migrating from this corner here (indicating) into the Borger field proper, here is a highly developed area in the southwest corner of Quadrant 2, Hutchinson County. There are a large number of wells in there,

closely spaced, which would probably take care of any drainage at all that might come from Carson—the western part of Quadrant 3 in Carson, or from Quadrant 3 in Hutchinson, the southwest corner of Quadrant 3 in Hutchinson to that area, so that local migration of that type does affect the situation.

Q. All right, that's all I want to know. There is drainage out of Quadrant 3 into Quadrant 2. It doesn't matter which wells they drain to, there is drainage from one quadrant to the other?

A. Well, over a period of years that condition has not materially changed and it is a minor consideration.

The Trial Examiner: Well, is there drainage, Mr. Hammer?

The Witness: Well, it is very questionable whether there is any. It is entirely, Mr. Examiner, a question of relative interpretation.

By Mr. Keffer:

Q. Mr. Hammer, you just said the drainage was coming from Quadrant 3, Hutchinson, and Quadrant 3 in Carson, was being caused by wells in the southwest portion of Quadrant 2.

A. Wait a minute, let's localize that statement. I didn't indicate the whole quadrant in either case.

Q. No, I know you didn't.

A. I stated that in the extreme southeastern corner of Quadrant 3 in Hutchinson and the extreme northwestern corner of Quadrant 3 in Carson there was indicated drainage there locally into a highly developed area in the southwest corner of Quadrant 2 in Hutchinson County.

Q. All right, then, your answer is there is drainage from Quadrant 3, Hutchinson, to Quadrant 2, Hutchinson?

A. In a minor part, in relation to the entire quadrant, yes, but it is a minor consideration.

Q. All right. Now, you don't know what the porosity or permeability is that might influence it in there? I think you already answered that. Strike it. I won't embarrass you by asking you the same question.

A. You aren't embarrassing me any.

Q. Now coming to Quadrant 3 we have a very much different situation, haven't we?

A. Quadrant 3 where?

Q. Hutchinson, as compared to Quadrant 1 in Moore County.

A. Well, different in one respect, between what?

Q. Your isobar lines.

A. Well, you are comparing the two. You say we have a different question—

Q. I said compared to Quadrant 1 in Moore County.

A. Well, now you are comparing what—Quadrant 3 in Hutchinson and Quadrant 1 in Moore?

Q. I say, we have a much different situation with respect —I will illustrate it this way—with respect to drainage in Quadrant 3, Hutchinson County, out of Quadrant 1, Moore County.

A. Compared to what?

Q. Compared to drainage out of Section—out of Quadrant 3, Hutchinson, into Quadrant 2, Hutchinson, or vice versa.

A. Yes, there is a difference. There is a different condition there.

Q. Well, it is rather substantial, don't you think?

A. Well, there is a different condition.

Q. Just tell us what condition you find there?

A. As to the position of the isobars—

Q. Well, let me state it. I think it would save time.

You take Quadrant 3 of Hutchinson County. You find a very decided pressure differential between that area generally and Quadrant 1 of Moore County to the westward, don't you, a difference I would say of at least 70 pounds starting from about the center where the word "three" is written on the Canadian River of Quadrant 3 over to the west line of the county, a distance of maybe four or five miles?

A. That is what the map shows.

Q. That is what the map shows. All right, you get on out into Moore County and you have 1, 2, 3, 4, 5, 6, 7,—well, we'll say 7—a difference of 70 pounds from the east side of Quadrant 1 in Moore County out to about the center of it generally, about where the figure 1 is. Does that seem to be about right?

A. Well, if you counted them right.

Q. All right, will you count them? I counted them hurriedly.

A. I would say that there are seven isobars.

Q. Yes. I counted seven but counted them hurriedly.

So you have a pressure differential about the center point east and west of Quadrant 1, Moore County, to about the center point east and west of Quadrant 3, Hutchinson County, of perhaps 140 pounds, haven't you?

A. With the exception that you have in Quadrant 1, Moore County, and in Quadrant 4—no, Quadrant 6, Moore County, two local high pressure areas which in both cases have arrested the movement of gas eastward and at least part of the gas is draining into low pressure areas to the west.

Q. All right, this high pressure area you refer to in Moore County, Quadrant 1, is very isolated, very small, isn't it?

A. Well, it exists and it is still there.

Q. I know, but as you show it on the map, you show it less than 640 acres in extent, don't you?

A. The fact remains that it is a barrier there locally.

Q. Answer my question.

A. Nearly. Approximately.

Q. Near the west side of the quadrant. How is that going to affect the drainage from the center?

A. It is not going to affect the drainage. The point is it does affect it in the northern part.

Q. Very little in the northern part because it is so small.

A. It has been there consistently over a five-year period and it is still there, or was still there when we made this map.

Q. All right, don't you know what this is?

A. Well, it is a high pressure area.

Q. How's that?

A. Well, the well is a high pressure well.

Q. Do you know what a "tight" is, a little local "tight"?

A. Yes.

Q. All right, you get a big well here and then drill over there 330 feet and maybe get a small well. What ordinarily

in a field of the characteristics of the Panhandle, what does that mean?

A. In general you would say it was an area of low permeability.

Q. All right, and then you go on. This was the big well. I said 330 feet, I'll make it 660—was a small well, and then beyond that was another big well, another 660 feet. Now, what would that indicate to you?

A. Well, it would indicate an area of perhaps—relatively speaking, it would indicate an area of larger permeability.

Q. Yes, but that well in between that small well where you hit what oil men call a "tight" spot, since you have got big wells around it would indicate a very small, tight area there, wouldn't it?

A. That's just the point. That's important there. If you have—

Q. Wait a minute. Answer my question first. You say yes?

A. I say yes, and that is very important there.

Q. All right.

A. If that is an area of low permeability, certainly gas is not going to migrate across it rapidly to the east.

Q. That's right, and if it covers less than a section, as your map shows, and I presume you made it as big as you conscientiously could—a section in a county is not very much, is it?—a section in a quadrant isn't very much?

A. No, not very much.

Q. Well, all right, now, you do have a very decided migration of gas as shown by your isobar maps from Quadrant 1, Moore County, into Quadrant 3, Hutchinson County?

A. In the northern part of the quadrant, no.

Q. All right, the south half?

A. In the south half there is an indicated gradient in that direction.

Q. Rather substantial?

A. It is rather substantial.

Q. All right. When reading your pressure declines in Quadrant 3 a while ago, that meant absolutely nothing.

A. What?

Q. Reading pressure declines over a period of years in Quadrant 3 in Hutchinson County, isn't that what you did?

A. I don't get your—

Q. When you made that speech of ten minutes a while ago, reading all those pressure declines into the record on Quadrant 3, Hutchinson County, making quite a point of it. Well, there wasn't any point to it, was there?

A. Yes, there was, and I can do the same thing, and I intend to do the same thing for the quadrant you are talking about.

Q. All right, that will be very interesting, Mr. Hammer.

If I can show you areas in Quadrant 3, Hutchinson County, a number of wells where the pressures are actually increasing while those wells are producing substantial volumes of gas, then that would mean to you, I think you said the other day, that that would mean that those wells were being repressured by drainage from other sources?

A. No, I didn't make that statement. I made the statement about repressuring that the Huber Corporation had done some repressuring in that area.

Q. Oh. we weren't talking about the same thing. Where did they get the gas to use?

A. They took it out of the ground and put it back in locally.

Q. Took it out of wells 600 feet away and put it in this one?

A. Locally, that's right.

Q. How can you figure by any stretch of the imagination that it is going to affect the pressure there by taking it out of one well and putting it back into another?

A. It simply means that if there weren't withdrawals, that they took the gas out and naturally when they took the gas out there was a proportionate decline.

Q. Going right back immediately?

A. All right, then they put the gas back in.

Q. Yes.

A. Having done that it will help to maintain that pressure in there. Certainly when you put gas back into the ground it helps to maintain the pressure.

Q. I see what you're talking about. All right. If I can show areas in there where that is not happening, where there is no mechanical repressuring, and wells that are producing lots of gas and you had increase in your pressure,

then what would that mean to you? Wouldn't that mean that they were being repressured by natural means by reason of drainage from some other source to the point of production?

A. It might entirely be a local source.

Q. What do you mean, a local source?

Other wells are producing down there, too. Keep your story straight, Mr. Hammer.

You get to the point many times, we'll say this isobar line where it is caused by local sources and then you get down here into another situation where there is drainage and then you say that is entirely local.

Now, those two things are rather inconsistent, aren't they?

A. No, I don't think so.

Q. All right, we'll let the record stand in that respect.

I believe, Mr. Examiner, that if we might recess for the noon hour that perhaps I could expedite the matter somewhat.

Mr. Lange: That is agreeable.

The Trial Examiner: Very well, Mr. Keffer.

The hearing will stand in recess until 2:00 o'clock this afternoon.

(Whereupon, at 12:30 o'clock, p. m., a recess was taken until 2:00 o'clock p. m., of the same day.)

Afternoon Session, 2:00 p. m.

The Trial Examiner: The hearing will be in order.

Mr. Lange: Mr. Examiner, we have some corrections that have been signed by counsel covering all of the volumes through XL.

The Trial Examiner: Fine, Mr. Lange.

Whereupon—

A. A. Hammer, the witness on the stand at the time of

adjournment, having been previously duly sworn, resumed the stand and testified further as follows:

Mr. March: Now, Mr. Examiner, Mr. Keffer made two requests for information to be furnished by this witness. The first was that Mr. Keffer wanted to know as to any statement made by the Railroad Commission of the State of Texas regarding the east and west field.

Will you read what you have from the annual report of the Texas Railroad Commission regarding that, Mr. Hammer, stating what report you are reading from and the page number?

The Witness: This is the Railroad Commission's report, of Texas, Ernest O. Thompson, Chairman; Lon A. Smith and C. V. Terrell, Commissioners. It is entitled "Annual Report on the Panhandle Oil & Gas Field, July 1938," by Oil and Gas Division, Engineering Department, November 1938, V. E. Cottingham, Director of Production.

On Page 4 of that report the following statement is made:

"An intervening structural restriction does not permit the free intermingling of gas, and the corresponding equalization of pressures, between the east part of the field and the west part of the field.

"This structural restriction resulted from a down-faulted block that occurs south of an east-west fault which roughly coincides with the north boundary line of the ACH & B Survey, and extends for a distance of approximately ten miles.

"Along the south side of this fault, the corresponding pay horizons have been faulted down below the water level, thus preventing the migration of gas through this down-faulted block from one field or zone to the other. North of this fault is a narrow strip of production which has been drilled to a density of approximately one well to ten acres.

"As a result of the heavy withdrawals from these oil wells, a low pressure area has been established which effectively impedes the flow of gas through these formations between the east and west zones.

"All of the gas in the east zone or field is sweet. The gas in the west zone is both sweet and sour, with sour gas occurring along a belt skirting the north flank of the Panhandle structure."

Mr. March: There was another request made by Mr. Keffer. Will you state what that is and state the information you were able to get?

The Witness: Please read that question.

(The question referred to was read by the reporter as set forth above.)

The Witness: As I understood Mr. Keffer's request, he wanted a statement of the ultimate reserves—when I say "ultimate," I mean the original reserves at 430 pounds pressure.

The Trial Examiner: The original reserves in place?

The Witness: Underneath the acreage, yes.

I have a tabulation here that I made some time ago showing not only the original reserves underneath Canadian River's acreage but the original reserves underneath the entire quadrant or quadrants in which the Canadian River has acreage. I noticed when I finally found this tabulation today at noon that the ultimate reserve by quadrants is calculated down to zero pounds. In other words, zero well head by quadrants, but there is a calculation of it, of the total of all quadrants down to 25-pound well head gauge. That is for both the Canadian River acreage and the total acreage in all of the quadrants in which Canadian River owns acreage.

Recross Examination (Continued).

By Mr. Keffer:

Q. Will you let us have that statement Mr. Hammer?
A. Yes.
Q. Will you let me see the Railroad Commission's report you just read from, Mr. Hammer?
A. Yes.
Q. That report was for what year?
A. 1938.

Q. 1938?

A. Yes.

Q. Now on the report that you just read from Mr. Hammer, there is nothing in that that shows that the east part of the Panhandle field and the west part of the Panhandle field are separate fields, is there?

A. It shows to all intents and purposes that they are separate fields.

Q. You didn't even draw your isobar lines showing separate fields, did you?

A. No, I didn't.

Q. And the Railroad Commission doesn't do it either?

A. I don't recall.

Q. You have seen their pressure map, Mr. Hammer?

A. Yes, but I wouldn't recall exactly.

Q. All right, you say there is a fault in this area indicated as ACH & B in Gray County?

A. Yes.

Q. It dips down where you have water encroachment?

A. Not necessarily water encroachment.

Q. How do you account for this producing horizon you show along the south of that?

A. As a matter of fact up to the time of 1939 in August while there were a few wells drilled in there, it is my very definite remembrance—I think I can truthfully say that there were none of these wells connected—

Mr. March: Identify that, please.

The Witness: That's in Gray County, Quadrant 5, and the area lying south of the structural depression as indicated on this isobaric map.

By Mr. Keffer:

Q. Well, now, the map shows very clearly that there is a connection between the east and the west field south of the fault, even though the statement you read from the Railroad Commission report indicated there was not?

A. No, it doesn't at all.

Q. I thought it indicated that. Well, you have read it. It speaks for itself.

Well, then, there is a connection—

The Trial Examiner: Pardon me, Mr. Keffer. Mr. Hammer, were you speaking of the map or of the report?

The Witness: At first I read the report to state exactly what the Railroad Commission said about it.

By Mr. Keffer:

Q. I know, but the Railroad Commission wasn't as clear to my mind at least as it might be. All right, now, we were talking about the fault along the south side of this fault that is this way (indicating).

Mr. March: Which way?

Mr. Keffer: South, as shown on the map, toward the bottom, the fault is indicated, that has the word "Gray" written in there on the map, Exhibit 179, indicated as a barren island in there, so to speak.

The Witness: Structural depression.

By Mr. Keffer:

Q. Yes. Now, that is the fault the Railroad Commission is speaking about?

A. No, the fault they are speaking about is this one up here, this line, as they state, through ACH & B Survey.

Q. Then south of the fault, if you go far enough south, there is a connection between the east field and the west field?

A. I think it is very definite, Mr. Keffer, that if the Texas Railroad Commission had thought that there was a passage for gas through there they would have so stated and they did not.

Q. I grant you that. I am taking your own map, Mr. Hammer, and asking you what it shows.

A. It shows that what few wells were drilled in there were wells of such character that no one having a pipe line felt justified in connecting them up.

Q. Why?

A. Well, because of low permeability, perhaps.

Q. What is low permeability? What does low permeability mean?

A. Wait a minute. I want to finish answering this question. Also this area right through here running from

Lefors south is structurally in relation to the west part of the field and the east part of the field, is a structuraly low area. Now, I did not make a structure map, but I did take enough logs in this general area to indicate to me that there is a low structural area there, a higher structural area here, over in Wheeler County, and another structurally high point beginning west of this area south of Lefors and extending on west until the high point is reached some place in Moore County.

Q. All right, Mr. Hammer. Now back again to the area—what is this quadrant?

A. That is Quadrant 5.

Q. That includes the barren space as well as that below?

A. Yes.

Mr. March: In Gray County.

The Witness: I might say, Mr. Keffer, in arriving at the area this was drawn out. It was not included.

By Mr. Keffer:

Q. You did not count the acreage as shown in the white?

A. No.

Q. But down where your isobar lines are you did compute that acreage and that is in Quadrant 5?

A. That is right.

Q. Now, you said those wells were small. I thought you said a number of times you didn't know the size of the wells in the Panhandle field and paid no attention to them.

A. That was an abstract thing. In certain cases like this when you want to find out reasons for some certain thing, why, naturally you would pay some attention.

Q. I thought so.

A. But as to the whole field, that was a different problem. Here was a special problem.

Q. You weren't interested in any part of the field, interested enough to observe potentials except that part in Gray County that you have referred to, is that right?

A. Except in an abstract way.

Q. What do you mean, in an abstract way?

A. Just in a general way.

Q. How was that?

A. I said, just in a general way.

Q. Generally, then, you know where the large wells are in the field, don't you?

A. In a general way, yes.

Q. Well, you know specifically in that spot?

A. Yes, and there was a reason for finding that out.

Q. Well, if you found areas where there were big wells, wasn't there some reason to find out why they were big?

A. No particular reason.

Q. Why wouldn't there be just as much reason to find out where there was a big well why it was big as to find out on a little well why it was little?

A. Well, the whole point is that I knew about this statement that was made by the Railroad Commission and I wanted to check to see additional reasons, if any, why they were, and I found them. Now, as I stated a while ago, if the Texas Railroad Commission had believed that there was any chance of gas passing across this area of low permeability south of that depression they would have so stated.

Q. All right, now you stated this morning that you weren't going to hazard a guess what the Texas Railroad Commission believed about anything. You absolutely refused to do that. Now you are quoting their belief.

A. I said if they believed it they would have so stated.

Mr. March: Let the record show a request was made to prove where the Railroad Commission made any statement in regard to the separation of the east and west field.

Mr. Keffer: All right, I appreciate that. I am trying to run the thing on down, Mr. March, that's all.

Q. All right, now I take it that if you were interested in five small wells in Quadrant 5 in Gray County you were interested in small wells all over the field.

A. Not particularly. I wasn't interested in them all over the field particularly. I was interested in certain small wells in Wheeler County. In areas, for example, where the wells had not been connected up, and naturally when I came to a thing like that I would wonder why.

Q. That's right.

A. And I would try to check to find out.

Q. All right, now, you found small wells out here in Potter County near the fault line, didn't you?

A. I don't recall any from memory, those wells, no.

Q. You found small wells down in Hartley County, didn't you?

A. Again I say I don't recall as to the potentiality of those wells.

Q. You found some small wells up in northwestern Hutchinson County, didn't you?

A. I don't remember the open flows up there.

Q. You just remember them in one spot, but you have got a pretty good recollection of them there, is that the status of the matter?

A. It was the only place where I had any reason to.

Q. All right now, Mr. Hammer, you stated that this was an area of low permeability.

A. I said indicated low permeability. At least that's what I meant to say.

Q. You think that it is, is that your opinion about it?

A. Yes.

Q. What do you base it upon?

A. Well, I base it largely upon the fact that the wells in that area are very very small.

Q. Suppose they had been very very large, then what would have been your opinion?

A. Well, if they had been large wells they would have been connected up, unquestionably.

Q. I am talking about permeability. I am not talking about connections.

A. Well, if the wells had been large the permeability might have been small or the permeability might have been large.

Q. Now, let's be consistent about it. If a small well indicates low permeability, why wouldn't a big well indicate a high permeability?

A. Well, in general a big well will.

Q. Now, in general—don't you know that you would have to have high permeability to have a big well, Mr. Hammer?

A. Immediately surrounding the particular well, yes.

Q. All right. Then, if you found—of course, you didn't make any study and didn't find,—but if you found in the south part of Moore County and the north part of Potter County big wells, what would that indicate as to perme-

ability? Just follow your question on out. Don't change your answer on it.

A. Well, it would have indicated that those wells were in an area of relatively large permeability surrounding each well.

Q. That's right. Then if all of them generally are large, why, the area then has a rather high permeability, doesn't it?

A. That would be a fair assumption.

Q. Well, isn't it a correct assumption?

A. Well, not in all cases, I wouldn't say that it was.

Q. All right, if you don't want to say so—now, if that is an area of high permeability then gas migrates at a more rapid pace than it does in a field where the permeability is low, doesn't it?

A. Again that depends upon the question of pressure differential.

Q. All right, take a given pressure differential, and pressure differential you want to take, just so it is constant.

A. It also depends on—

Q. Answer my question.

A. What is his question?

(The question referred to was read by the reporter, as set forth above.)

The Witness: Again I use the word "relatively," yes.

By Mr. Keffer:

Q. All right, that is as strong as you want to go?

A. That is as strong as I will go.

Q. I suspect that's strong enough, anyway.

Now, Mr. Hammer, I went into a matter this morning as to Gray County more or less at random, and I want to take one of the quadrants in Moore County and go into it more specifically. Will you take your exhibit—I guess it's 180—and look on Page 5, Table 3?

Before I get to that, I really hadn't finished Wheeler County, but I am coming to that next. You say that the area south of the fault which you have referred to and which the Railroad Commission has referred to in Wheeler County—north of the fault, let's take that area just north

of the fault which I take it is included in your Quadrant No. 7, Gray County, is that correct?

A. Yes, that is correct.

Q. Now, as a matter of fact, the area north of that fault line has been an area of high gas production, has it not?

A. Yes, it has produced a lot of gas.

Q. They have big wells in there, haven't they, a number of them, at least?

A. Yes.

Q. And they have produced large volumes of gas.

A. In times past, yes.

Q. Yes, that is in the Lefors area, the casing heard carbon black center in the Panhandle field, isn't it?

A. I think there used to be; some of them are gone now.

Q. Why gone?

A. Well, because the gas in that particular local area probably is exhausted.

Q. Now, you have a low pressure area in there, haven't you?

A. That's right.

Q. All right, now, gas drained from west of that low pressure area from the westward into it—

A. From the westward of that low pressure area from—from the westward of Lefors?

Q. Yes, out in here. You don't show any line in there at all, it is so low, across here?

A. That would be a very questionable assumption.

Q. What's questionable about it?

A. Well, here is a higher pressure area just north of this fault line and coming up against the fault line, higher than the north of Lefors.

Q. What would be the direction of the migration of gas from this higher pressure area you are talking about into the lower pressure area?

A. It would be going into the north.

Q. Migrate into it, wouldn't it?

A. Yes.

Q. And we have a situation where gas to some degree at least could migrate from the west area into the depression around Lefors and could likewise migrate from the east-

ward into the depression around Lefors. It can come both ways. It has to meet from the two sections.

A. However, it is the opinion of the Texas Railroad Commission that gas from the east of that area doesn't move over to the west.

Q. The Railroad Commission didn't say that?

A. Oh, yes, it did. Read it.

Q. All right, here's what they say:

"As a result of heavy withdrawals from the oil wells, a low pressure area has been established which effectively impedes the flow of gas through these formations between the east and west zones."

A. All right, it says it effectively impedes.

Q. All right, we weren't talking about gas going across it. We were talking about gas going into it from the east and also coming into it from the west. Now, there is nothing in there that says that doesn't happen, is there?

A. In a purely localized condition it would happen.

Q. You say "localized." You have been using that a lot. Just what do you mean by "localized"?

A. Well, just as the isobar there indicates, a local condition.

Q. Define that local condition.

A. Well, actually the great number of oil wells that exist in this area, that have not been isobarred—

Mr. March: Describe it a little more fully.

The Witness: That is in the southwest part of Quadrant 7, Gray County, and the southeast corner of Quadrant 8, Gray County, and the northeast corner of Quadrant 4 in Gray County.

By Mr. Keffer:

Q. Why didn't you run your isobar lines on out there?

A. Because there were no details given in the Texas Railroad Commission—no data to work on.

Q. This is a new gas field and as you stated large volumes of gas have been produced?

A. That's right.

Q. All right, I think that is enough on that.

Now, referring to your Exhibit 180, Mr. Hammer, let's look again at Quadrant 1 in Moore County—no, Potter County.

All right, I had it almost right—going to Potter County, 1, the area that I am pointing to here on the map, when you considered that quadrant as such you got a weighted—that is, an acre pound factor of 58.92, didn't you?

A. Potter 1?

Q. 58.92.

A. 58.97.

Q. All right, that's near enough, 58.97. When you considered Moore 1 in connection with Potter 1, you got what—47.88, wasn't it?

A. 47.88, that's right.

Q. And when you considered Moore 2 in connection with Potter 1 you got in Potter 1 36.82, didn't you?

A. Now, wait a minute. Let's see if I understand what you want.

Q. Just what I asked.

A. Now, I don't understand.

Q. All right, when you were determining what was in Moore 2 you also considered Potter 1?

A. It was grouped together.

Q. That's right. At that time you gave Potter 1 a value of 36.82, didn't you?

A. You are talking about Potter 1?

Q. That's right, yes, sir.

The Trial Examiner: What you are asking for is the Moore 2?

Mr. Keffer: No, I am asking the different weights that he gave Potter 1 each time he made a different calculation.

The Trial Examiner: For another quadrant?

Mr. Keffer: That's right.

The Trial Examiner: I don't think he understands that.

Do you understand that, Mr. Hammer?

The Witness: No, I don't. I think there is some confusion here but I don't get it.

Mr. Keffer: Let's straighten it out. We'll wait until you get it.

The Witness: In the final analysis, on Page 6, Tables 4 and 5, Exhibit 180, the production per acre pound there for Potter 1 is 58.97.

By Mr. Keffer:

Q. In consideration with what?
A. What?
Q. In consideration with what?
A. Well, that is the production per acre pound that was arrived at by grouping the—by the group method of arriving at a fair figure for production per acre under—
Q. I know, but that isn't what I have been asking you.
A. That is the condition, whether you have been asking it or not.
Q. Well, let's start all over again. Maybe I can simplify it a little bit.

How many times did you use Potter County 1 when you were computing the value of other quadrants?

A. It was utilized on five occasions.
Q. That's right. All right, now, when you were arriving at what its relative weight was, or its per acre content, or acre pounds decline was—I'll get it right yet—when you were figuring for Potter County 1 as such, you got 58.97, didn't you?
A. That's right.
Q. And when you were figuring Moore County 1, you gave Potter County 1, 47.88, didn't you?
A. No, I didn't do that at all.
Q. All right, what value did you give to the area which included Potter 1 when you were figuring the Moore 2?
A. All right.
Q. Just answer my question. That's all I want.
A. I am going to.
Q. No, you got 47.88. Say "47.88," then you have answered my question.
A. For what?
Q. For what you gave to the area which included Potter 1, which included every acre in Potter 1—47.88.
A. In Potter 1?
Q. Potter 1.
A. No, 58.97.
Q. No, that was Potter 1 considering it alone, not alone, but considering or determining the remaining reserves in Potter 1. That's what you figured it was based on, a factor of 58.97.
A. That's right.

Q. You can follow me on this. It isn't difficult.

Now, when you came back to determine what it was in Moore County 1, just to the north of it, then you gave Potter County 1 a different value, didn't you?

A. No, no, no, no, no, I didn't do anything of the kind.

Q. All right, you gave the area a different value, didn't you?

A. I simply utilized Quadrant 1 in Potter 2—

Q. Let's don't go over all that again.

The Trial Examiner: Mr. Hammer, there is no necessity for going through all that again. What Mr. Keffer is trying to get at now, you have used Potter 1 on five occasions when you were determining reserves under the quadrant—

The Witness: Under adjacent quadrants.

The Trial Examiner: That's right, and what he wants to know is not what reserves you assigned to Potter 1, but what reserves—or what reserve was attributed to Potter 1 as a part of the total area you considered as apart in reaching your result on these other quadrants.

The Witness: That's just the point.

The Trial Examiner: That is not what you are doing.

The Witness: That is the point I am trying to make, that each one of these, the value for each quadrant was calculated independently by taking the summation of the factors in adjoining quadrants.

The Trial Examiner: The record is very clear on that.

The Witness: We didn't use any independent—we didn't group these after we had got a production per acre pound. We used them before that independently and arrived at a production per acre pound for each quadrant in relation to its adjacent areas. Now, I don't find any such figure that Mr. Keffer is talking about.

By Mr. Keffer:

Q. You will find it exactly as I will state it to you. You follow me.

Mr. March: Not the description that you give.

Mr. Keffer: Maybe you can help on the description. I would appreciate it.

Mr. March: Maybe you can describe the figure and maybe he can answer it right off. Come and show him the figure you want. Take the exhibit.

By Mr. Keffer:

Q. You have considered Potter, Quadrant 1 on five different calculations, as you have stated.
A. It has been grouped with that many.
Q. Five different groupings, I'll put it that way.
A. All right.
Q. All right. Now, when you were considering Potter 1 as such you got a factor of 58.97, didn't you?
A. Yes, 58—considering it as such.
Q. As such, yes.
A. That is the figure at which we arrived from the grouping of the acreage to apply to Potter 1.
Q. That's right. I understand that perfectly. Now, when you made your next calculation on it which involved Moore County, Quadrant 1, that time the acreage in Potter County, Quadrant 1, had a value of 47.88.
A. No, that is not at all right.
Q. Well, tell me what's wrong with it.

Mr. Spencer: All the acreage in the quadrant including that in Potter 1, had that value?

The Witness: Yes, the grouped acreage.

Mr. Spencer: That's right.

By Mr. Keffer:

Q. That's right. Well, that included Potter 1, and Potter 1 had the same value on your computation as all of the acres in the group, in that particular computation, didn't it?
A. No, not at all.
Q. Well, Mr. Hammer, when you figured Moore County 1, you took into account Potter County 1, didn't you?
A. Yes.
Q. And Moore County 2?
A. That's right.
Q. And Hutchinson County 3?
A. That's right.

Q. And Moore County 6?

A. That's right.

Q. I don't know whether you took in Potter County 2 or not.

A. I did.

Q. I take it that would be all of them. I am not checking it from the record but just looking at the map here. All right, what was the value of all of the acreage in that group of quadrants?

A. To arrive at a production per acre pound for Moore Quadrant 1.

Q. 47.88, wasn't it?

Mr. March: Let him answer it.

The Witness: Well, let's see—47.88.

By Mr. Keffer:

Q. Now, you assigned that value in order to get your value of Moore County 1 to every acre in that group of quadrants, didn't you?

A. No, I arrived at that figure as the average for the total group.

Q. That's right, and applied it to every acre in the group without any distinction in making your average to get a figure for Moore County 1?

A. That's right.

Q. Then you necessarily in that computation assumed that Potter County 1 had 47.88?

A. No, I didn't, no, not at all, because you lose sight of these various groupings that were utilized.

Q. No, I don't lose sight of them at all.

A. When you throw out—

Q. If you don't like the manner in which I stated the question, let me state it this way:

When you made your computation and got your average that applies for the purpose of that computation, you applied it to every acre in those group quadrants?

A. It was the average production per acre pound determined for that group.

Q. That's right, that's what I have been talking about, that is, for every acre in the group the average, taking all of the acreage in the group?

A. That's all right as far as this particular quadrant is concerned.

Q. All right, you are asking the answer for quadrant 1, I know, but you had to find the average weight in all those quadrants and that figure was 47.88?

A. All right, that applies as far as arriving at that is concerned.

Mr. March: Identify it.

Mr. Keffer: Wait a minute—on the average, as a whole, which included Potter County 1, you necessarily in that computation assigned 47.88 to Potter County 1?

The Witness: That's all right, I'll agree that that was arrived at for that particular thing.

Mr. March: When you say "that particular thing," you mean Potter County 1?

The Witness: That's right, in arriving at a production per acre pound for that alone.

Mr. March: That's right, none of the rest.

The Witness: No, we simply utilized the others to arrive at that figure.

By Mr. Keffer:

Q. All right, then when you came down to computing Moore County, Quadrant 2, you used Potter County 1 again, didn't you?

A. Yes.

Q. And that time your overall average figure was 36.82, wasn't it?

A. You are talking about Potter 2 or Moore 2?

Q. I am talking about Moore 2.

A. 36.88, that's right.

Q. 36.82; then you utilized Potter County 1 again in figuring Carson County, Quadrant 4, didn't you?

A. Yes.

Q. And that time you got an overall weighted figure of 81.43, didn't you?

A. That's right.

Q. And when you came down to figuring Hutchinson County 3, you used Potter County 1 again, didn't you?

A. That's right.

Q. By that time you had an overall figure of 45.94, didn't you?

A. That's right.

Q. Now, in the various calculations made from time to time and in which Potter County 1 figure was utilized, the figure has varied from 36.82 to 44.95?

A. Not at all.

Q. The figures that you utilized in these various computations?

A. That isn't a fact at all.

Q. What is the correct assumption?

A. Well, I have explained dozens of times and I will do it again—

Q. We don't want to go into it again.

Mr. March: Let him go ahead. It might be helpful.

By Mr. Keffer:

Q. He can go ahead if he wants to. I don't want to burden him with too many things.

A. As I have stated on previous occasions, we used the principle of taking any given quadrant on which we wanted to determine the production per acre pound and we used the adjacent quadrants to that. In other words, the summation of the data is what it amounts to for the entire area, and then from that determined a production per acre pound for the quadrant in question. Then we applied that to the weighted average pressure as of 1939.

All right, if we move over, we'll say from Quadrant 2, Moore County, to Quadrant 1, Moore County, we didn't utilize Hartley, Quadrant 4 or Quadrant 3, Potter, for the reason that they weren't adjacent to it. Then we took the areas immediately adjacent to Quadrant 1, Moore, and arrived at a production per acre pound for that area; then if we moved over here to Quadrant 3, Potter, we utilized the areas adjacent to that and arrived at a production per acre pound for that, in Quadrant 3.

Similarly we did that throughout the entire area. Now, it is obvious that in arriving at a figure to apply to a given area where you used different areas and different production, you are bound to have a different production per acre pound. Now, that's the whole story.

Q. I understood that perfectly, Mr. Hammer.

Now, Mr. Hammer, just one more time, and try to follow me, please, on this and let's don't spend all afternoon on it.

Now, when you got your figure in Potter 1, which is a figure that you assigned to it which you state is the correct figure of 58.97, now, that figure was an average of that quadrant with surrounding quadrants, wasn't it?

A. That's right.

Q. That's right. All right. When you came down to figure Moore County 1 you again got an average of surrounding quadrants, didn't you?

A. That's right.

Q. Which includes Potter County 1?

A. That's right.

Q. The average at that time was 37.88?

A. It included the original data.

Q. Well, I know it included the original data.

A. Before any production per acre pound had been calculated.

Q. But every time you get a different grouping you get a different average for the quadrants within the group which necessarily assigns to the quadrant we are speaking of a different value each time you make a different calculation?

A. Let's see, repeat that.

(The question referred to was read by the reporter, as set forth above.)

The Witness: Well, that is because you take in different areas each time.

By Mr. Keffer:

Q. Granted.

A. Certainly you do.

Q. But you get a different figure?

A. You get a different figure because you have different data to work on.

Q. And the original figure which you take is the correct one is also determined by averaging in others?

A. The summation, yes, of all of the quadrants around a given quadrant and the quadrant itself.

Q. Now, Mr. Hammer, can you go this far with me on

production. The best production in the Panhandle field is generally found through the axis portion.

A. Well, there are some qualifications to that.

Q. Generally that would be true?

A. Generally I would say that would be true.

Q. How did you figure out your quadrants?

A. Well, we attempted to lay them out so they would give as fair a representation as possible of all of the factors considered in the area in which we were interested.

Q. You say "we laid them out." Whom do you mean by "we"?

A. My boys were working under my direction.

Q. Who were the boys that were working under your direction?

A. I have had eight at different times, but the final decision was up to me.

Q. I know, but did all of you get together and work the thing out and determine where each quadrant was going to be?

A. I wouldn't say that, but we discussed it at different times.

A. You actually put them on, is that right?

A. Physically, no. I outlined them.

Q. What were the determining factors in placing the quadrants on your map?

A. Well, trying in the first place—there were two determining factors.

Q. All right, name them

A. The original maps were on a scale of 4,000 feet to the inch. If my remembrance is right this is a reduction of one-fourth. We laid those quadrants out so that the arm of the planimeter we were using would cover an area without moving the instrument.

In addition to that we tried to so fit those areas that it would take into consideration as near as we could use what appeared to be the factors that would more nearly represent the area as to drainage, either to or from a given area.

Q. All right, on your Moore County Quadrant 1, you just missed that a long ways from the drainage standpoint, didn't you?

A. No, I don't think so.

Q. Well, look at your isobar lines.

A. As far as any effective drainage in Moore County—

Q. Oh, I am talking about the field as a whole. You have got your quadrants all over the field.

A. All right. I think it is fairly representative for the reason that there has existed up here in Moore 6 prior to 1937 a low pressure area in that district.

Q. All right, let's take Carson County 3, Quadrant 3, you missed it on that one, didn't you?

A. What?

Q. You missed the drainage question on that one, didn't you, Carson County 3?

A. No, I don't think so.

Q. You don't.

A. No.

Q. Do you think there is no drainage out of that quadrant?

A. I said this morning only a very very minor amount.

Q. I don't care—

A. There is some there, yes.

Q. Probably some—don't you know that there is a lot?

A. I don't know that it can be measured.

Q. All right, I'll say, could you have made a worse choice possibly than that one as shown by your isobar lines if you were trying to limit it to areas that reduced drainage in or out to a minimum?

A. Could I have done what?

Q. Could you have missed it more any place in the field that you did right there?

A. I think that is perhaps the best that could be done under existing conditions.

Q. When you drop down like that, taking just about the south half of it and leave out that northern line where your lines are going down so rapidly?

A. Well, that wouldn't have made any particular difference.

Q. All right, now, just be frank with me, Mr. Hammer. When it gets down to it, your quadrants were put on there as a matter of convenience and that's all.

A. Not necessarily.

Q. The only thing you have given—you have ignored drainage completely?

A. No, I haven't.

Q. Well, why should you draw the Carson County Quadrant 2—3, rather, as you did, if you are keeping the drainage question in mind?

A. Well, because the only effective point where the configuration of the isobars indicated drainage to the north.

Q. Well, it is drainage regardless of which way it goes?

A. Let me finish.

Q. All right.

A. Was that area in Carson adjoining an area to the north in Hutchinson where conditions were similar.

Q. All right. The north part of this block is similar to the conditions in Hutchinson County, isn't it, yet how about the south part of it?

A. Well, that isn't—

Q. It is all in the quadrant.

A. I know, but in making the determination, that isn't important at all.

Q. But you said the matter of drainage is important. You said that was one of your predominant motives.

A. I didn't say that it was one of my predominant motives. I said it was one of the factors taken into consideration.

Q. You took that and the matter of convenience in running your planimeter around. I cross examined you on that. I took it at face value. I want to know how much consideration you have given the drainage, that's all.

A. As a matter of fact, we didn't give an awful lot of consideration to drainage farther than it affected the grouping of these quadrants to arrive at it.

Q. Precisely, you gave your consideration to it when you made your computation, as you stated a number of times.

A. It was all balanced in.

Q. You gave little, if any, consideration to the drainage problem when you were seeking where the quadrants were going to be and where the boundary lines were going to be?

A. We gave it consideration.

Q. You just thought about it, is that the consideration you gave it?

A. Well, you must remember this, or anybody must, that this map here is a composite of a lot of larger maps, and we worked the thing out the best we could for the counties and then joined them together and we found out when we did that that they tied up nicely along the county line.

Q. All right, let's come over to Quadrant 2 in Carson County. You didn't pay much attention to drainage there, either, did you, as shown by your isobar lines?

A. Well, when we got that far away we didn't—

Q. I am talking about the field. Forget about Canadian River.

A. When we got that far away the only consideration just as I stated before was the balancing of that as against the other.

Q. When you got that far away from what?

A. From the position where Canadian River has acreage.

Q. Forget about that. When you selected these quadrants all over the field, you covered one end of the field to the other. We are talking about the field with reference to your selection of quadrants.

A. Well, and when we came to the point of arriving at a production per acre pound those were balanced in.

Q. I am not asking you that, Mr. Hammer. My point is, you didn't—you gave very little, if any, consideration to drainage in determining where those quadrants would be on your map?

A. That is true. We weren't making a drainage study. We were only making a study for reserves.

Q. You could have said that right at the start and saved a lot of questions. I think that's enough on that.

One other thing I almost forgot here. In balacing your quadrants, as you go down the structure, and especially in the western part of the structure, you necessarily include those quadrants along the center in more computations than you do the computations out on the edge, don't you? You use them more times?

A No, I don't think so.

Q. All right, let's just figure them out and see if you

don't. They are contiguous to more quadrants, aren't they?

The Trial Examiner: Perhaps, Mr. Keffer, you might save a little time if you would specifically designate the quadrants that you have reference to.

Mr. Keffer: Well, I didn't have reference to any particular one. We'll take Moore County 1, as an example.

Q. How many times have you used that one?
A. Moore 1?
Q. Yes, in your various computations.
A. If I have counted correctly, five times.
Q. Five—is that all?
A. That's right.
Q. All right, how many times did you use Hutchinson County 3?

The Trial Examiner: Mr. Keffer, was the first one Moore 2?

Mr. Keffer: Moore 1, Moore 2, Quadrant 2.

The Trial Examiner: Did you give your answer for Moore 2? Was that five—does that apply to Moore 2?

The Witness: Yes, I think so.

Mr. Keffer: Oh, the first one I asked him was 1. The one we are working on now is 2. I beg your pardon, Mr. Examiner, I misunderstood you.

The Witness: If I understood you correctly, you asked for Hartley 3.

By Mr. Keffer:

Q. Oh, there isn't any Hartley 3.
A. I mean Hutchinson 3.
Q. I did, yes. I asked you for Moore 1, Moore 2—
A. No, you started—
Q. Maybe—I believe you're right about that—sure as the world, I think you are. I'll be corrected on that.

Now, let's count them. I think we can count them right here on the map. You used Moore County 1 when you were figuring its own value you assigned to it, didn't you?

A. I used the original data, yes.

Q. That's one time.

A. Yes.

Q. Then you used in figuring Potter County 1, you used it, didn't you?

A. Now, we are talking about Hutchinson 3?

Q. No, we are talking about Moore 1, how often you used it.

A. Yes.

Q. You used it on Potter County 1. That's two, isn't it?

A. That's right.

Q. You used it on Potter County 2, that's three, isn't it?

A. That's right.

Q. You used it on Moore County 2, that's four, isn't it?

A. That's right.

Q. You used it on Moore County 6, that's five, isn't it?

A. I didn't calculate it on this down here—oh, in arriving at Moore County?

Q. Your field reserves.

A. Yes.

Q. What do we have there—six or five?

The Trial Examiner: Six.

By Mr. Keffer:

Q. You used it again over here when you were figuring Hutchinson County 3, didn't you?

A. Yes, that's right.

Q. That makes seven, and you had two others. You would have to check to be sure—Hutchinson 4 and Moore County 5. I don't know whether you used either one of those or not, but we do have seven definitely.

Mr. Spencer: They used Carson 4, they say, so that would make eight.

By Mr. Keffer:

Q. Now, does that appear to be right to you, Mr. Hammer?

Mr. March: I'll tell you, Mr. Keffer, I think you slipped up one. We can have him make a check on that during the recess and bring in what it is exactly on all of them. These gentlemen here said you slipped up one.

Mr. Keffer: I tried to count them.

Mr. March: We can check those.

Mr. Keffer: In fact, it doesn't make so much difference over here. It runs in practically—

Mr. March: We can have the witness check—

The Trial Examiner: Mr. Keffer, perhaps if you will specifically designate the quadrant that you desire that information on—

Mr. Keffer: Moore County 1, Moore County 2 and Hutchinson County 3. I think that would be enough to illustrate the point.

The Trial Examiner: Those are the quadrants that you desire, Mr. Keffer?

Mr. Keffer: Yes. It will be a very small matter to compute it.

The Witness: It would.

The Trial Examiner: He wants it for those three.

Mr. Keffer: I want it to illustrate and to show particularly what it is in the west part of the field.

The Witness: Did someone make a note of that? I didn't get those written down.

By Mr. Keffer:

Q. That was Moore 2, Moore 1 and Hutchinson 3.

You might take one other—take Hartley County, also, and one more, Wheeler County 1, also.

A. Are we going to have a five-minute recess here?

Mr. Keffer: I am not going to add any more here. Take Wheeler County 1. I would like to see what it shows.

The Witness: I am not sure that I have here the information on Wheeler County.

Mr. Keffer: Just give us what information you have on it, Mr. Hammer, and that will be all right.

The Witness: It will be entirely from memory because if it needs to be exact I would want to check it.

Mr. Keffer: That's all right. We might have a recess at this time.

The Trial Examiner: Very well, we will stand in recess for five minutes.

(At this point a short recess was taken, after which proceedings were resumed as follows:)

The Trial Examiner: The hearing will be in order.

By Mr. Keffer:

Q. Have you computed the use of the various quadrants referred to and the respective various computations, Mr. Hammer?

A. Yes, I have rechecked them. I will just read them and give them to you:

Q. That will be perfectly all right.

A. I used Moore County Quadrant 1, six times; used Moore County quadrant 2, seven times; used Hartley County Quadrant three times; used Hutchinson Quadrant 3, four times.

Q. Well, now, you are just including Canadian River's computations there?

A. That is what I utilized in my exhibit.

Q. I know, but I was asking for the field as a whole, Mr. Hammer.

A. That wasn't my understanding at all.

Mr. Spencer: That is the last thing we said.

Mr. Keffer: I intended certainly to make that very clear.

The Witness: I understood his last statement was that he wouldn't ask me for anything but Wheeler 1.

Mr. March: That was what it was. I remembed it distinctly. We will be glad to figure this out for you, but in the five-minute recess we had he was unable to define any more. We will computte the others after the recess this afternoon.

By Mr. Keffer:

Q. You used Moore County 2, seven times, as you gave it there?

A. That is true.

Q. You used it again in figuring Quadrant 5, Moore County, didn't you?

A. I presume so but I would have to check it.

Q. It is just broadside against it. I think you would be safe in saying that.

A. I would say that was right.

Q. I think on your basis you used it in computing Moore County 4, didn't you?

A. You are talking about Moore 2?

Q. Yes, you used Moore 2 when you computed Moore County Quadrant 4?

A. I believe so, but that—

Q. Of course, your isobaric lines would indicate a drain from Quadrant 4 to Quadrant 2?

A. I believe that is true.

Q. That would make Moore County 2, nine times. You can check that, if that is not correct, and correct it. That would make it nine times, wouldn't it, as we have discussed it?

Come over to Hutchinson County Quadrant 3, you would have used it again in computing Moore County 6, wouldn't you?

A. I believe we did.

Q. And in computing Hutchinson County Quadrant 5?

A. No, Quadrant 4.

Q. Oh, I see. Quadrant 4?

A. That is right.

Q. That would be two more times, Hutchinson County 2?

A. I imagine it would be.

Q. That would be three more times?

A. That is right.

Q. And possibly Carson County 3—you will probably want to check on that.

A. I would want to check on that.

Q. Anyway, that would make Hutchinson County 3, seven times and possibly eight times, is that correct? You can check it tonight.

A. I would want to check it.

Q. Now, you have used those quadrants along your axis more than you have the quadrants out on the edges on either side in the west part of the field, haven't you?

A. Well, before I would want to answer that I would want to check the rest of these quadrants. We have just picked out a few here.

Q. All right, you might check them on either side and see what the difference is, if any.

A. I wouldn't want to make a definite statement until I could check them.

Q. It stands to reason where you have a quadrant that is entirely surrounded you necessarily use it more times than a quadrant out on th edge of the field and where you just have quadrants on three sides of it. That would almost certainly follow, wouldn't it?

A. I imagine that is true. I would want to check it.

Q. All right, you check that and tell us if that isn't absolutely true. You can do it without much difficulty, can't you?

A. I can do that tonight.

Q. Now, Mr. Hammer, we had something about Wheeler County 1. What was your information on that?

A. Well, on Wheeler County 1 our information was that—well, in 1939 there were really no gas wells in Quadrant 1, Wheeler, and apparently the past history was such that the operators, outside of a couple of little oil pools that were in there, hadn't thought enough of the territory to drill it for gas, so we didn't consider Wheeler County Quadrant 1 as really being commercial gas territory.

Q. Well, then, how did you figure the reserves in it?

A. We didn't give it any reserve.

Q. None at all?

A. No.

Q. You just figured it out?

A. Threw it out.

Q. You didn't figure it in with any other reserves?

A. I don't believe so, no.

Q. Now, how many wells did you say were in that?

A. In Quadrant 1?

Q. Quadrant 1 of Wheeler County.

A. My remembrance—you are talking about gas wells?

Q. Gas wells, that is right.

A. I don't recall offhand but I think there were no gas wells that were hooked up. My remembrance is that there weren't in that area to exceed two wells that were even

considered as gas wells and they were very small wells quite a long distance from the pipe lines, and it was my opinion that that area over there in Quadrant 1 of Wheeler County really shouldn't be considered as productive territory.

Q. You did have some oil wells in there that had produced some substantial volumes of gas, hadn't you?

A. Well, it probably had, but the oil wells themselves didn't amount to very much. As compared to the rest of the field, they were small wells.

Q. Had there been much pressure decline in that area?

A. Well, around those pools, as nearly as we could get the information, there was considerable decline. I would say this, that of all the area in the entire field there was less data upon which to base anything in Quadrant 1, Wheeler County, than in any of the rest of them.

Q. Then the upshot of it is, whatever it might be worth, there are some areas in the field even today where you don't feel justified in applying pressure decline methods?

A. Or any other method.

Q. Why didn't you try the sand thickness porosity method on that for a little diversion to see how you came out?

A. I didn't have any time to waste.

Q. Are there any more quadrants like that in the field?

A. Well, there are some that approach close to it.

Q. What are they?

A. I would have to do a little checking on that.

The Trial Examiner: Do you mean, Mr. Keffer, Quadrants which he had disregarded or had similar characteristics?

Mr. Keffer: That had similar characteristics to Wheeler County 1. He might not have disregarded them but as a matter of fact, I don't think he did.

The Witness: I may have some notes on that. Does someone have available that exhibit that we put in on the reserves for the entire field?

Mr. Lange: Yes.

The Witness (Examining document): Wheeler 1 on Exhibit 186, on that you will notice it was assigned no reserve

at all. You will also notice on the same exhibit 186 that Wheeler Quadrant 5—

By Mr. Keffer:

Q. Which one?

A. Wheeler 5.

Q. Wheeler 5?

A. Yes. We could only give that a remaining reserve per acre of about 2,921 Mcf., which is very small for productive territory.

Q. Is that per acre or for the Quadrant?

A. No, that is 2,121 Mcf. per acre. Of course, what I am talking about are the figures on remaining gas reserves per acre. Actually you will notice that the highest assigned to any of the quadrants in Wheeler County is 6,980 Mcf. per acre.

Q. Remaining reserve?

A. That is right.

Q. Down to the 25-pound abandonment pressure?

A. That is right. That shows that there are some areas there, particularly Wheeler 5, that if you had to drill them today you probably wouldn't drill them because of the small amount of gas per acre.

Q. Take Wheeler County 5, what is the pressure on that, Mr. Hammer?

A. You mean the weight of the pressure?

Q. Yes.

A. Well, I don't know that I have that with me. I really don't believe I have, Mr. Keffer.

Q. Well, you can tell by looking at the map it is very, very low, can't you?

A. I think that is right.

Q. Do you know how low it is?

A. I wouldn't want to say until I checked it.

Q. Sir?

A. I wouldn't want to say until I checked it.

Q. Let's look at the map, Exhibit 179. I think it will indicate that.

A. It will show the isobars.

Q. Wheeler County 5 starts with the pressure on the south side, having a pressure of about 200 pounds?

A. That is correct.

Q. Then it varies from about 90 to 200 pounds.

A. Yes, from 200 at the high to about 90 for the low.

Q. Are there any other quadrants in the field you find in about that situation, Mr. Hammer?

A. No, in general I wouldn't say there is.

Q. How about the quadrants over in Gray County, Quadrant 2?

A. Well, that appears to be, although the pressure is relatively high there, this has been assigned to a low amount of gas per acre.

Q. A what?

A. A low amount of gas per acre.

Q. You show better than 8,000,000 feet per acre remaining?

A. Yes.

Q. That is down to 25?

A. Yes.

Q. Isn't that a pretty substantial volume of gas?

A. It might be under certain conditions.

Q. Has there been any production much from that quadrant?

A. No.

Q. No production from them?

A. There has been—their production has been very small.

Q. How did you get your estimate on it? Did you use the porosity sand thickness method on that one?

A. No.

Q. Tell us how you did it?

A. Well, by balancing or grouping—I am talking from memory because I don't have these groupings here.

Q. I understand.

A. My remembrance is that we used Quadrant 1 and Quadrant 4 in Gray County, Quadrant 5, Gray County, and Quadrant 4, Gray County. In other words, we grouped this area right across here south of the structural depression.

Q. I am not sure that I understand you. Rather than use the porosity sand thickness method you threw that in with another quadrant, didn't you, and considered it all as one quadrant? Didn't you throw that in with Quadrant

5 of Gray County and ignore your boundary lines between quadrants?

A. No.

Q. You didn't do that?

A. No. I feel quite sure—as I said, I would want to check that.

Q. In weighting that number 5 down there with the others when you had no production, how did you reach out and get a weighting figure, a figure you used in your weighting process?

A. Well, there was production on both sides of it, both to the east and to the west.

Q. You took the production in other quadrants and determined that that ought to be the production in Quadrant 2, Gray County, is that right?

A. Well, we assigned—

Q. Sir?

A. We grouped that just as we have grouped the others except that we couldn't group anything to the north of it, so that is my remembrance, we grouped it to the east and west of it.

Q. We may be talking about the same thing, Mr. Hammer, but the whole point is that on Quadrant 2 in Gray County you didn't have enough data to figure it by itself?

A. That is true.

Q. Now, in order to get enough data to figure it you had to go out and throw it in with some others and get an average figure, an average of what they all showed, and bring it back and assume that would be the figure on that before you started your averaging process, is that correct?

A. I don't think you could say we assumed anything. We simply took both areas and used the same process there.

Q. But in these county quadrants we have been talking about, except Wheeler 1, you had basic data you could utilize in each of the quadrants, and now you come down to Quadrant 2 in Gray County and you don't have that basic data. From what source did you get it?

A. I said that my remembrance is we took the data from Quadrant 1 and 4—no, Quadrant 1 and 6 in Gray County and Quadrant 4 in Gray County.

Q. All right. Now let me restate it.

You took what value you had in Quadrant 4, Gray County; Quadrant 1, Gray County; Quadrant 6, Gray County, and averaged that up, is that right?

A. Yes, we utilized those entire areas. That is my remembrance.

Q. Then you took that figure, whatever it was, that average figure, and arbitrarily applied it to Quadrant 2 to supply the missing data?

A. That is right.

Q. I thought we understood each other.

Now, as a matter of fact, Mr. Hammer when its gets right down to it you could have missed on your pressure decline quite a little, couldn't you?

A. Well, the data aren't as good as they are elsewhere.

Q. That is right, and you have already said with the pressure decline to be really good you have to have data behind it.

A. Yes, that is right.

Q. And the more data you have the better it is?

A. That is right.

Q. Now you have answered, I believe, or have shown us the acre content of that quadrant, that is, the remaining pressure to the 25 lb. abandonment, and I presume since there has been that little production the original reserves would be very similar to the remaining reserves?

A. No. Regardless of how small a permeability you might have, there would be bound to be some movement to nearby wells. In other words, I can't illustrate an area entirely because you don't know the extent—in other words, there hasn't been enough development in there to give you sufficient data.

Q. There hasn't been enough to get even the rock pressure there?

A. No.

Q. I mean the sand thickness porosity there.

A. No.

Q. So you are both about in the same boat from that viewpoint?

A. I think so.

Q. Now, to get over in Gray County quadrant—just

south of that high spot in Gray County Quadrant 5, I guess it is—

A. That is the one we have been talking about?

Q. Sir?

A. Isn't that the one we have been talking about?

Q. Just a minute.

We were talking about the same quadrant after all?

A. Yes.

Q. Now let's go to Quadrant 5. What is your treatment of Quadrant 5, Gray County?

A. In general it is the same treatment for that as in the quadrant we had been talking about previously.

Q. Now, I believe you stated you had sufficient interest in that area which would be Quadrants 5 and 2, Gray County, being the area just south of the Gray County faulting, which we referred to earlier this afternoon, to make a much closer check on that than you did on other parts of the field, is that corerct?

A. In general as to the wells, I would say that was true.

Q. What did they show in there as to the number of wells and the size of them, Mr. Hammer?

A. I don't have that data with me but from memory it showed the wells were of very small potential.

Q. Yes, I believe you stated that earlier, didn't you?

A. Yes.

Q. Did it show a number of dry holes in there?

A. I would have to check that, Mr. Keffer.

Q. Do you have data with you whereby you can check the dry holes on that area?

A. I doubt it. I don't know whether I could or not.

Q. What attention do you pay to a dry hole in applying the pressure decline method?

A. Sir?

Mr. Keffer: Read the question, Mr. Reporter.

(The question referred to was read by the reporter as set forth above.)

The Witness: Well, a dry hole automatically indicates that immediately around the hole there isn't any—in other words, it is so tight, to use the oil field expression, that gas can't get into the part of the formation penetrated by the bit.

By Mr. Keffer:

Q. Suppose you found a good many of them in Quadrant 5, particularly in Gray County, and some of them in Quadrant 2, what would that indicate to you?

A. Well, under reservoir conditions as they seem to be and the character—I will put it another way. The character of the producing formation in the Texas Panhandle would be—I think I can best illustrate that, Mr. Keffer, the point I am trying to make, by telling of an occurrence that happened to me elsewhere.

Q. All right, go ahead.

A. We were drilling a hole for the Northern Pacific Railway Company in the state of Montana and a bunch of school teachers came out to—

Q. To tell you how to do it?

A. —to see this drilling rig. They said to the driller, a man by the name of George Waldrip, "How much territory will this hole condemn down there when you hit that sand at about 4500 feet?"

Without hesitation he said, "Madam, six inches, four thousand feet underground."

That is the point I wanted to bring out here.

Q. I get your point exactly.

Let's apply it both ways, Mr. Hammer. Coming back to the leases you were talking about so much this morning and which you held down to about 640 acres, why didn't you hold them down to about six inches there each way around the hole? They were tight spots and we agreed on that.

A. Well, you are coming to the question of the variables of permeability.

Q. But if a dry hole in a tight spot over here condemns practically nothing, then a small well in a tight spot over in the west part of the field which creates a higher pressure area there which you referred to would mean nothing or little, wouldn't it?

A. No, I wouldn't agree to that.

Q. All right.

A. Because—

Q. That is all right.

Now coming back here to Gray County again, figuring

your acreage in there, you ran your isobaric lines as you showed them there and figured in dry holes?

A. I took the entire area.

Q. You didn't count anything out for the dry holes on the theory you figured six inches was all that was condemned anyway?

A. That is right.

Q. That would give you possibly an exaggerated figure down there of acre content in that area?

A. Well, I think that is a good point there to illustrate. If you utilize an area like that with other areas you automatically, because you do use it, create a lower reserve in another area.

Q. Why do you?

A. Well, because you are taking into account bigger acreage for the same amount of gas that has come out.

Q. You figured those areas right close to eight million feet, two of them, I expect, per acre, so that is a pretty high figure to start with for dry holes?

A. What two are you talking about?

Q. Quadrant 2 and 5, Gray County.

A. Well, the point there—You mean just those two?

Q. Sir?

A. You mean just those two?

Q. Yes.

A. Well, it is possible that—I will put it this way, if I may answer the question in my own manner.

Q. All right, go ahead.

A. Under present conditions of supply in that territory it might not be economical to drill or try to produce from that area, but there may come a time when economic conditions change and when it would be profitable to operate in that territory.

Q. I take it you mean by that when you get a great deal more for your gas than you can get today?

A. That time will eventually come. It has every other place.

Q. In other words, though you are not producing much gas you are getting more per thousand *tuibc* feet, for example, and maybe the time will come sometime in the distant future when somebody will drill it?

A. I think that if that area there, for example, were in the Appalachian field they would be drilling wells in it.

Q. I wonder if we could move it over there? Do you know any way we could do it? I wonder if we could drill our wells over there instead of in Gray County?

A. I think that is it.

Mr. March: Another one of your affiliates are doing that, Mr. Keffer.

Mr. Keffer: I don't understand that, Mr. March.

Mr. March: I think another one of your affiliates are doing that.

Mr. Keffer: All right.

Mr. Spencer: I didn't know Mr. Keffer had any affiliates. I am glad to know that.

Mr. Keffer: That is right. I have a wife and daughter. I guess they are affiliated.

Mr. March: I was speaking professionally.

Mr. Keffer: All right.

I have one further question along that line, Mr. Hammer.

Q. The area we have been speaking of, Quadrants 2 and 5, particularly, in Gray County, hold pretty well true to the conditions you found there in the southern portion of Quadrant 4, Gray County? You didn't find much deviation there, did you?

A. Well, I wouldn't say that would be a true statement of the situation.

Q. I will qualify it to the degree you think it ought to be qualified.

A. I would say that the southwestern part of Quadrant 4 and the northwestern part of Quadrant 3 in Gray County would probably be better territory than that to the east.

Q. Very much better?

A. It is better.

Q. Can you find any connected well in that area?

A. Yes, there has been some production out of that territory.

Q. Did you find any dry holes in that area?

A. I believe that there were one or two that I remember.

Q. Well, did you find the wells in that area were generally small, this additional area you described or referred to?

A. You mean the area to the east?

Q. Yes. Were these generally small wells?

A. I think in general that is true, that is, along the extreme edge at that particular point.

Q. What is the pressure generally prevailing in that area as shown by your isobar map, Exhibit 179?

A. Which area, Mr. Keffer?

Q. In areas designated by Quadrants 2 and 5, Gray County, and 3, and the south part of Quadrant 4 in Gray County.

A. There is one well just south of this depressed area here situated in Quadrant 5, Gray County, that was reported by the Texas Railroad Commission to have a pressure of 435 pounds in 1939.

Q. In Quadrant 4 the pressure in the south part would be from 380 pounds upwards, would it not?

A. No, because in the southeastern part of Quadrant 4, Gray County, with the northeast Quadrant part of Quadrant 3, the pressures there got down to 360 pounds—

Q. That is the result of one well, isn't it?

A. No, I think there are two wells there.

Q. Two wells pulled it down but otherwise the pressures will run from 380 pounds up to virgin rock pressure, or near that, to 430 pounds, is that correct?

A. The Texas Railroad Commission in 1939 reported the pressure there at 435 pounds.

Q. 435 pounds?

A. Yes.

Q. That would be true of the wells in Quadrant 2, Gray County, and Quadrant 5, Gray County?

A. That is right.

Q. And in Quadrant 3, Gray County, except for that area of two wells that you spoke of, is that correct? In fact, this Quadrant 3, except for that area, consists of wells 400 pounds and above? I mean except the isolated area of the two wells which you referred to.

A. Yes, that is right.

Q. So the area prevailing in there is much higher—I mean, the pressure in that area is much higher than the general average pressure of the field?

A. Yes, that is true.

Q. Now, Mr. Hammer, in applying your pressure decline method—strike that.

You made a statement that it might take a million years for the field to equalize?

A. I think I made such a statement.

Q. How did you figure that out? How did you calculate it?

A. It was just an expression.

Q. As a matter of fact, it has only taken about fifteen years at the outset for it to get in this shape, hasn't it?

A. That is quite a different problem, Mr. Keffer. The thing that put—

Q. Just answer my question. It has only taken it about fifteen years to get in this shape, hasn't it?

A. That is right.

Q. Then gas will continue to flow as it has in the past and if it ate its way back to this position in fifteen years, isn't it reasonable to assume that something like that time or not much longer would cause it to equalize if those wells were shut in?

A. No, I don't think so. You see you are overlooking, Mr. Keffer, the fact that the thing that produced that low pressure area was gas that came out of the ground, vertically against—or, rather, vertically through conduits that had no *resistence* as far as permeability was concerned. That is quite a different problem from—

Q. What conduits are you talking about?

A. The tubing and the casing.

Q. I surely agree with you, but that is where you get into that six inch situation again?

A. Yes, but those casings come vertically out of the ground to the surface.

Q. Yes, I understand that, but how does that gas get to the casing in order to come out? What must it do first?

A. It has to have a pressure differential, of course.

Q. What does it come through to get to that casing?

A. The producing formation.

Q. The producing formation?

A. Yes.

Q. What does it go through when it is going to equalize across there?

Mr. March: You are presuming—

Mr. Keffer: I am not presuming a thing on earth, Mr. March. Mr. Hammer has testified it would equalize.

Mr. March: But he hasn't testified in equalization it would all run to the Borger area. It would be a hot spot in Borger if it all went over there.

Mr. Keffer: Go ahead and answer the question.

The Witness: Please read the question.

(The question referred to was read by the reporter as set forth above.)

Mr. Keffer: I will add "from the low pressures to the high pressure areas."

The Witness: Of course, it could only pass through the reservoir.

By Mr. Keffer:

Q. Every foot of gas that has ever been produced has passed through the reservoir at some distance or other to get to the well?

A. Certainly.

Q. If it didn't do that you would just produce the six inches that the casing uncovered?

A. Certainly.

Q. Now to go to these Panhandle Eastern Shamrock wells we talked about a little yesterday afternoon. We found there when a well was first drilled in that area that one-fourth of the pressure was gone, didn't we?

A. We found out the pressure had been reduced. I don't remember the exact amount.

Q. We figured out 109 pounds was the pressure in one case and it was a little over 100 pounds in another case, which would be more than a fourth, figuring down to your 25-pound abandonment pressure which you have figured. That pressure had lost 25 per cent of it in how long? How long did it take it to do that?

A. Well, that is a question that is largely—I don't believe it can be answered unless you knew the dates of all of the wells that had been drilled close to them and I don't know them.

Q. Let's assume they were drilled within the past two or three years, what would your answer be then?

A. They haven't been drilled within the last two or three years.

Q. How do you know that?

A. I know that in that area there within two or three miles of where those wells are that there hasn't been any wells drilled because they were drilled in 1939.

Q. 1939?

A. Yes.

Q. That has been less than a year?

A. Yes, since they were drilled.

Q. Did it lose that 25 per cent in a year's time across that two or three miles?

A. No, they—what time are you talking about—between when they were drilled and now?

Q. Yes.

A. I don't have any pressure as of this date.

Q. Do you know when the wells were drilled—the last wells are what we are talking about. They were drilled in an area which had lost through drainage, we will say, roughly 25 per cent of the gas then?

A. Yes, they had lost some gas.

Q. My point is, how long did it take that particular area to lose that 25 per cent of the gas?

A. Well, you tell me when this area up in the east part of Quadrant 6, Moore County, developed, and I can give you an answer.

Q. I will give you that in just a moment. However, before I give you that, let me remind you that you had all that drainage down to the south and the southeast, and not up to that spot at all.

A. When?

Q. Yesterday afternoon when we were discussing those wells.

A. Oh, no.

Q. I asked you where the gas went and you figured out a well down here in the Charles Ragsdale Survey as to where the gas would drain in the area where those wells were drilled.

A. I don't think the record shows that. I said "locally." I am talking about the local load down there.

Q. You tried to leave the impression, or you did leave the impression with me, that the drainage was caused locally by those wells inasmuch as they were nearest to the southeast.

A. The point is that this area here in Quadrant 6, Moore

County—I don't recall the exact date—has been a low pressure area there for a number of years and the chances are that any gas from the area where these wells were drilled in 1939, there would be the lowest low pressure area and it would have the most direct effect upon it. That would be to the northeast.

Q. Why were you stating yesterday evening that the drainage was caused locally by the wells to the southeast?

A. Here is your low pressure area right in here between the high pressure area and another high pressure area at a higher pressure area down here (indicating), local low pressure area. Here is a low pressure area (indicating). Naturally you are going to get local drainage into the local low pressure area.

Q. You want to say now it is drained over to the Byrd-Armstrong pool in Quadrant 6?

A. I think that would have the greatest effect upon it.

Q. It is about six miles on an average?

A. No, it is about three miles.

Q. From where are you measuring to?

A. I am measuring from the high pressure area and from the high pressure wells. You can pick out any sections you want to down here and it will measure three miles.

Q. You took the high pressure wells. What I want to know is about those low pressure wells that had lost 25 per cent. It is altogether a different question. Those low pressure wells wouldn't drain across the high pressure well you measured in between and the low spot around the Byrd-Armstrong pool, would they?

A. No.

Q. Then when you said they lost their gas from the southeast you really meant that, didn't you?

A. I want to qualify that, Mr. Keffer.

Q. All right, qualify it.

A. This is only one map out of the five that we made. I would have to recall some way what the previous year's configuration showed.

Q. Do you have those other maps so that we can take a look at them?

A. They are in Washington, D. C.

Q. Does Mr. Roosevelt have them, or somebody up there?

A. They are all ready if somebody wants to look at them.

Q. Well, I won't go get them. The fact remains there has been drainage; let's agree on that.

A. We will agree on that.

* * * * *

Witness HAMMER further testified on cross examination, Vol. 57, pp. 7949-8107, inclusive, as follows:

The witness stated that the diverse conditions prevailing throughout the field and in particular areas in the field were not taken into account precisely in laying out his quadrants; that each quadrant contained various characteristics. There was a great variation in some of them in the producing ability of wells, particularly in Quadrant 2, Potter County. The variation was also great in Moore County Quadrant 2.

The witness also explained in this connection that a planimeter, which had influenced him in laying out the quadrants, was a device for measuring areas on a map and computing acre content.

The witness made no study of dry holes generally and did not remember whether Canadian's wells near the fault line were small or not. He just wasn't interested in the open flows of the wells at all. He stated that the southern and eastern sides of Wheeler County did not look good to him from a producing standpoint because the dolomite sections in those areas were not thick. He also stated that northern Hutchinson County was an area of low or slow open flows. He did not particularly remember the size of the wells in northern Gray County and Carson County along the limits of the field.

It didn't make any difference to him about the variation in open flows and other producing characteristics in his method of determination. This he says was all weighted out and eliminated by a process of grouping and averaging surrounding quadrants. He did this by starting from the west and going east, and says, he automatically took these things into consideration progressively.

For example, he took into account but four different quadrants in estimating the acre-content of the Hartley County Quadrant, but if these four quadrants had just been one area or one quadrant, then in order to determine the acre content he would have balanced this one large quadrant

with all adjoining quadrants. He would not have just taken the one large quadrant and figured the data on this quadrant alone because to have done so he would have eliminated other quadrants that would have a greater bearing on the matter. For example, Quadrant 3, Moore County, also Quadrant 2, Moore County; Quadrant 5, Moore County and Quadrant 2, Potter County, and if all of these quadrants were eliminated it would affect his result. Also, in figuring the Hartley County Quadrant as he did figure it, he gave no weight at all to the quadrants last mentioned.

A prior series of maps, prior to Exhibit 179, were taken into account in his reserve study, but these maps were not available for checking.

The witness further testified as follows (Vol. 57, pp. 7980-8016):

Q. Mr. Hammer, we were discussing quadrants generally in the western part of Moore County and the western part of Potter County, weren't we?
A. Yes.
Q. And I asked you if you could not have made your estimate just as well and gotten the same result in so far as Hartley County quadrant was concerned by considering only Potter County 3, Moore County 3, Moore County 4, and Hartley County all as one quadrant and one area.
A. And my answer was that this map doesn't represent what has happened over the five-year period that we utilized. This is a map for one year. There were changes some places.
Q. Well, obviously, you admit whether based upon this map or upon other maps that Moore County 4, Moore 3, Potter County Quadrant 3 all affected Hartley County quadrant, and as you say, you averaged them—that is not the word—
A. Grouped them.
Q. You grouped them?
A. Yes, that is true. I also stated that we had utilized it necessarily because it existed—a large area in Quadrant 3 and Quadrant 4, Moore County, which hasn't at any time indicated any drop in pressure. In other words, it is virtually virgin territory, but because we had utilized it, the resulting reserve was a minimum.
Q. I know you stated that. I believe it will be higher,

but we will argue that later. I think our position is clear in that respect.

Now, you just stated Quadrant 4 in Moore County; Quadrant 3 in Moore County, were virtually virgin pressures, I believe?

A. Part of them, that is right.
Q. Take them as a whole, they are all very high pressure areas?
A. Yes.
Q. And a great part of it is virgin pressure?
A. That is right.
Q. Are there any wells much in Quadrant 4 and Quadrant 3 in Moore County?
A. Well, there are a good many wells in Quadrant 3, Moore County.
Q. Where are they?
A. There is a well in Section 18, Block G & M Survey; there is another well in Section 22; there is a well in Section 23; there are two or three wells along the southern border in Block 019 in Quadrant 3.
Q. That makes about six wells?
A. So far. I am not through—
Q. Go ahead.
A. There are several wells along—
Q. Let's be specific. Let's don't say "several."
A. All right.

There is one well in Section 76. I think that is the EL & RR, Block P Mc Survey. There is another well in Section 73, G & M Block 2.

Q. Let's say that consists of two wells. Go ahead.
A. There is a well in Section 30—
Q. Let's check that well. It is very close to the edge, isn't it?
A. All right. There is another well in Section 22, EL & RR Survey, Block P MC. There is a well in Section 21 for the same survey—of the same survey. There is a well in Section 18 in the same survey; there is a well in Section 20 of the same survey.
Q. That would be seven of them.
A. There is a well in Section 14 of the same survey.
Q. Eight.

A. Mr. Keffer wants me to mention this dry hole in Section G & M Survey.

The Trial Examiner: As a well?

The Witness: He wanted me to and I told him it was a dry hole. I believe that is all except—I think those are all of the wells in there.

By Mr. Keffer:

Q. What about the next quadrant, Quadrant 4, Moore County?

A. That has little development.

I think it only has one well in the northwest corner in Section—

Q. Section 308, Block 44?

A. Section 308, Block 44.

Q. Now, Mr. Hammer, the one well in Quadrant 4, Moore County, which you referred to is in the very northeast section of the quadrant, isn't it?

A. Yes, that is right.

Q. Just as completely in the corner as it is possible for a well to be so far as the section is concerned?

A. It couldn't get much farther in the corner.

Q. All right. Now, of the eight producing wells you mentioned in Quadrant 3, two of them are right on the south line; that is, they are on Sections that really dip over a little into Quadrant 3, Potter County, aren't they?

A. They are right along the county line.

Q. That is right, right on the very south boundary line of your quadrant?

A. That is right.

Q. And the other six producing wells that you mentioned are right along in the southeast corner of the quadrant, aren't they?

A. In general they are in the southern part.

Q. That is right, and the farthest one away from your east quadrant line is about a mile and a half?

A. That is about right.

Q. There is an area, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20—no, I got down too far.

Well, we'll take this Quadrant 4 first. Quadrant 4 is ten miles long by 9 miles wide, that's 90 square miles, isn't it? Answer my question first.

A. Well, that's right, but a great part of it is outside Quadrant 4—is outside the limits of the field.

Q. That's right, I would say about half of it, roughly.

A. Well, my guess would be more than that.

Q. Well, if you started here with a straight line and came out over here (indicating), you would have about half.

A. Well, call it half.

Q. I think that would be a pretty close estimate, half of it.

We had 90 square miles, so we have got 45 square miles in there with one well, haven't we?

A. That's right.

Q. All right, now, we'll take this other quadrant, this Quadrant 3. It is about 9½ miles north and south and 9 miles east and west. Call it 9 miles square, that's 81 square miles, I believe, with eight producing wells.

A. All right.

Q. And those eight producing wells are all close to the south edge or the southeast line of the quadrant.

A. All right, that's true.

Q. And all of that is in the producing area as you have it outlined?

A. That's right.

Q. So you have there 81 square miles plus 45, that's 126 square miles, with 9 producing wells, all of them near the edge of the area, haven't you?

A. That is true, as far as you have gone, but—

Q. Yes, all right.

A. But you have left out of your consideration Potter Quadrant 3.

Q. I don't know whether I want to come to it or not, but I haven't come to it yet.

A. There are quite a number of wells down there.

Q. But the statement I have just made with respect to Quadrants 3 and 4, Moore County—

A. In general that is true.

Q. Now, don't you have far more wells per acre, far closer spacing of wells in Quadrant 5 and Quadrant 2 in Gray County than you have in Quadrant 3 and Quadrant 4, Moore County?

A. Read that question, please.

(The question referred to was read by the reporter as set forth above.)

By Mr. Keffer:

Q. Far more?
A. No, I would say there were fewer wells.
Q. Per acre, if you are considering the acres?
A. Fewer wells.
Q. Well, how many wells do you find in those two quadrants, including your dry holes?
A. Well, I find, as near as I can tell from the map, six wells. I can't say whether they are dry or not from the map.
Q. All right. Now, take the area that we have referred to, Quadrant 5, Gray County, and Quadrant 2, Gray County, limiting it to the confines of the field, taking your scale, don't you find at least twice as much area out here in Quadrant 3, Moore County, and Quadrant 4, Moore County, than you find in Quadrant 2 and Quadrant 5, Gray County, this area right in here (indicating) than in this area (indicating)?
A. Yes, the acreage is larger.
Q. So you really have more wells per acre, closer spacing of wells over in that quadrant—that is, Quadrant 5 and Quadrant 2, Gray County, than you have in Quadrant 3 and Quadrant 4, Moore County, haven't you?
A. Compared to acreage that is possibly true.
Q. Now, I think you will find more wells over there, Mr. Hammer. I am not assuming that you counted all the wells. It is hard to do it on this map. I appreciate that the scale is so small, but that is enough to illustrate the very thing that I have in mind.

I believe I asked you that the wells are better grouped over Quadrant 5 and Quadrant 2, Gray County, than they are over Quadrant 4 and Quadrant 3, Moore County?

A. You don't mean better grouped—
Q. I mean they cover the area—they are better distributed—that's the word.
A. Yes, that is true.
Q. That is correct. Now, if you didn't have enough data to figure Quadrant 5 and Quadrant 3, Gray County, which you said yesterday that you didn't have, and had to take the figures from some other counties to get that—some other quadrants to get that—then you didn't have enough out here to figure Quadrant 3 and Quadrant 4, Moore County?

A. That is an analogy that doesn't exist.

Q. Tell us why.

A. Over in the quadrant we are talking about in Moore County with the exception of that one dry hole, the Brown I believe you call it, there haven't been any wells, at least to my memory, to indicate that the development would not continue on to the west. In other words, you have over here in Hartley County a gas well. All right, now, you have a gas well over here and you have a series of gas wells over in Quadrant 2 and you have some gas wells in Quadrant 3, and you have gas wells in Quadrant 5, Moore County, and you have a gas well in Quadrant 8, Moore County. There isn't any reason to suppose but what this territory across here is not all productive territory.

Q. That may be very true, but that still doesn't answer my question. You have had that same situation over in Gray County, didn't you?

A. Well, but the point is that we have more reason to believe that conditions are similar in Moore County.

Q. No, I don't believe you understand my question. You had wells that were located pretty generally over Quadrant 2 and Quadrant 5, Gray County, enough to give you, I should say, a very good picture of those two quadrants.

A. None of those wells, as I stated, and as I think you agreed, had been connected up. They had not given out any production. The wells over in Moore County have.

Q. All right, but the wells have been giving up the production; they weren't in the area that you were estimating?

A. No, naturally; part of that area has not been drilled.

Q. Now, you take Quadrant 4 and Quadrant 3, great areas in which no wells have been drilled, and a great, major portion of that area which has not been drilled is 430 pounds virgin pressure, as you have figured it?

A. Yes.

Q. As you have figured it, and all of them are high. Now necessarily when you were averaging those quadrants in with Quadrant 5 and Quadrant 2, we'll say, Moore County, to get the production out there in Quadrant 4 and Quadrant 3, and your rock pressure was one of the most important things in that average, you have actually taken wells, very largely over in 5 and 2—Quadrants 5 and 2, and assigned to them the rock pressures on Quadrants 4 and 3 in your averaging and got a distorted figure, didn't you?

A. You have left out an equally important factor.

Q. All right, you name it.

A. That is the acreage involved.

Q. That is important. Now, you go ahead and answer it.

A. Well, now, by the very method—let's take for example one example and I think it will suffice.

Q. All right.

A. We have mentioned before and I will try to explain it again, if you take Quadrant 2, Moore County, and just assume that there is no production at all in Quadrant 3, and you make your determination on Quadrant 2 alone, then using the same production in Quadrant 2, if you then embrace all of the acreage in 3 and combine the two, the result will be a minimum result because you have taken in so much more acreage.

Q. There would be a minimum result per acre?

A. Minimum result per acre pound.

Q. Per acre, I'll grant you that.

A. Per acre pound.

Q. But doesn't necessarily result in the minimum per billion cubic feet in the area reserves?

A. Yes, it does.

Q. You tell us how.

A. If you get a minimum production per acre pound and you apply that to the acreage—

Q. I know, but you have got twice as many acres or maybe three times. That is the catch in the whole thing.

A. Well, the point is that—this whole thing is based on the production per acre pound. Now, if you get a production per acre pound—

Q. When you get a production per acre pound, in order to get the production for the area you would multiply it by the acres, wouldn't you?

A. Well, when you get the production per acre pound that is the first thing that is determined.

Q. Oh, of course, and then the next thing, you multiply it by the acres and the more acres you have got the more reserves you have got?

A. By acres and by pounds.

Q. You have already had your pounds.

A. And by the volume of gas. You have three factors.

Q. Well, no, the volume of gas is what is your answer. You don't assume what that is before you start your calculation. That is what you end up with.

A. No, but you determine first your production per acre pound.

Q. Surely.

A. All right, then, and assume that you would double your acreage, it would cut your production per acre pound decline in half.

Q. Of course, but still you would have twice as much acres in the reservoir because you double your acreage

A. Well, you would have a larger amount, that's true.

Q. All right. We had a big argument on that the other day and I think we finally settled it.

The Trial Examiner: We will take a short recess.

(At this point a short recess was taken, after which proceedings were resumed as follows:)

The Trial Examiner: The hearing will be in order.

By Mr. Keffer:

Q. Just another question or two, Mr. Hammer, on the things we were discussing, to gather up some loose ends.

You have originally your virgin pressure and comparatively little production in Quadrants 3 and 4, Moore County.

A. In general that is true.

Q. You have more production in Quadrant 5, Moore County, and Quadrant 2, Moore County, which is just to the west of 4 and 3.

A. Just to the east.

Q. I mean just to the east.

A. That is true.

Q. Now, it was necessary as a matter of fact—as a matter of fact, it just resulted, in the way you did it, that you take production pretty well, almost entirely, in Quadrant 5 and Quadrant 2 to determine your values in Quadrants 3 and 4?

A. Yes, they were grouped in, that is true.

Q. And the grouping resulted, since most of your production was in 5 and 2, most of your pressure drop was in 5 and 2, you evidently had to take—or in your adjusting,

you necessarily gave effect to those factors in 5 and 2, to determine your reserves in 3 and 4?

A. Yes, that is right.

Q. That's right. Now, in 3 and 4, if it should develop into a lean area—remember they are on the edges of the field there—although the pressures are relatively high, then you have got too high a figure for 3 and 4. That would follow, wouldn't it?

A. If they should develop to be lean, that is true, but we haven't any reason to suspect that they will.

Q. Did you examine the sand thickness on that—porosity?

A. Hardly.

Q. All right, now, if you had done that you would have gotten some idea of that, wouldn't you?

A. Sir?

Q. If you had done that you would have gotten some idea about it, wouldn't you?

A. No, I believe it wouldn't have helped any to speak of.

Q. You don't?

A. No.

Q. If you had studied the geology of the field and found that where your formations are dipping downward that your production begins playing out, just as you found over in Gray County and Wheeler County—

A. That isn't—

The Trial Examiner: Wait until he finishes the question.

By Mr. Keffer:

Q. —you would then have considered from that factor that the areas in Quadrant 4, Moore County, and much in Quadrant 3, Moore County, would have been light areas—lean acreage, wouldn't you?

A. If the assumption you make is true, it would be true, but you are comparing something over in Gray County with something over in the northwest part of Moore County.

Q. Oh, no, I'm not.

A. —and right along this edge of Moore County is a highly prolific area.

Mr. March: Quadrants—

The Witness: Quadrants 7 and 8, and down on the edges of the field.

By Mr. Keffer:

Q. That is the exception in the Panhandle field.

A. It is the closest to the area we are discussing.

Q. Well, now, let's see if it is. How about this right here, this right in the corner of Quadrant 3, along Potter County, you find small wells there.

A. I'll agree that there are small wells there but there are large wells here in northern Moore.

Q. Even those large wells don't go right out to the boundary lines of the field.

A. They exist just the same.

Q. They may be a little closer than in some other place, but that tapering off even begins there, doesn't it?

A. I wouldn't say that from memory that it did.

Q. As a matter of fact, isn't the reason they come out close and taper off so quickly that you have a very definite pronounced down-dip there that you don't have around here?

A. Well, I started to make a structural map of the field and never had time to complete it.

Q. You just don't know, then?

A. I wouldn't know as to the local dips there; no.

Q. Now, just what effect, if any, then, have you given to the degree in which one quadrant affects another quadrant, Mr. Hammer?

A. Well, there are various—when you use "degree," there are various degrees, so it is difficult to—couldn't you be more specific? I don't know that I understand you.

Q. Well, maybe so. One quadrant you say does affect another quadrant.

A. I said that there is some effect, that is the reason they were grouped.

Q. Now the degree may be different in each—in different cases. Now, what effect do you give to the variance with which one quadrant might affect another as compared to any other grouping?

A. Well, I think the method we used in balancing these out fairly took care of all of—of any variables in degree as between quadrants that were utilized.

Q. I know you think that, but I am asking you to give the reasons why you think that, is what I am really after.

A. Well, as I have repeated several times, it is a question of balancing and grouping areas adjacent to the quad-

rant in which we wanted to get a production per acre pound from which we could calculate.

Q. As you have explained heretofore?

A. That's right.

Q. That is the only method you have used?

A. That is right.

Q. Now I come back, Mr. Hammer, to large wells you referred to in Quadrant 8, Moore County, maybe some of them Quadrant 7, also Moore County. How do you know those wells are large?

A. Well, suppose I answer that this way—I will have to look at the map.

Q. My point is—I might explain it a little more fully—you state a number of times you paid no attention to the size of the wells, that's the only thing.

A. I said as to individual wells.

Q. Well, those are individual wells, aren't they?

A. Well, it is just another case where I know from having looked at a few of the open flows and having discussed the area that it is a highly prolific area and having even read since I left there of some very large wells being drilled in there, I just naturally know that it is a highly—an area of high potentiality.

Q. Yes, all right. Then you do definitely associate productivity with the size of wells in that area?

A. I said potentiality—

Q. All right.

A. Open flow. I know that the potential there is high.

Q. And you have also said that is a prolific area. Then you associate the two—in that particular spot, I am talking about?

A. Well, there is an association there, yes.

Q. How's that?

A. There is some association, that's right.

Q. That's right. I think there is a very definite association, don't you, between the two?

A. No, I wouldn't say it is very definite.

Q. Now, Mr. Hammer, let's be perfectly frank. Every time you want to make a point by associating them you do, and when you would rather not associate them because it might go the other way, you don't.

Mr. March: I object to that remark by counsel.

Mr. Keffer: Wait until I finish.

Q. Isn't that your reaction to the whole thing?

A. No, that's not my reaction.

Mr. March: I object to the question and move that it be stricken because it is apparent here that the witness testified that when he made this estimate of reserves he didn't have to give that consideration, that he did have some general knowledge of the field, but in the preparation of this exhibit he did not have to locate the wells of large open flow throughout the field.

I realize, Mr. Keffer, you have gone to a great deal of pains here to try to put the witness in the position of accusing him as you have right now. I move that the question and answer be stricken.

Mr. Keffer: I will permit it to be stricken. I have no objection to the question and answer being stricken if you want it that way.

The Trial Examiner: Very well.

Mr. March: You realize I want you to have free cross examination, but not to the extent of deliberately—well, I won't say that. We'll strike that, too, because we might get into a large discussion here. You understand my position, Mr. Keffer.

By Mr. Keffer:

Q. All right, now, refer to Page 14 of your statement, Mr. Hammer. Now, I read from your statement as follows, Page 14:

"Furthermore, it is axiomatic that in anything made up of components having diverse characteristics, an average based on the whole is fallaceous and invalid for the reason that it does not weigh in the characteristics of its diverse component parts."

Now, that being true, you didn't take the field as a whole, did you?

A. That's true.

Q. That is apparent in many, if not all of your quadrants, isn't it?

A. That's right. It was balanced out, not for the field as a whole.

Q. When you balanced out, you mean just what you have said heretofore about balancing?

A. That's right, grouping.

Q. Grouping, that's right, and you had those diverse characteristics in some groups, too, didn't you?

A. Yes, but—

Q. But, nevertheless—oh, pardon me.

A. —in the system of grouping that we used we attempted in every way possible to take into consideration those diverse characteristics locally.

Q. All right, now, right there—but assuming that you did just that, did everything that you could, yet what you did in the various groupings was merely to take an average, wasn't it, that was the best you could do?

A. Well, weighting, yes.

Q. All right, your weighting was your average?

A. Yes, it amounted to an average for each quadrant.

Q. Which is the very thing you say in the statement you can't do without getting a false answer, isn't it?

A. No, I don't think you understand what I meant there.

Q. Yes, I understand perfectly what you said there in your written statement and what you said in answer to my question a moment ago.

A. The point is that we didn't take into consideration the whole. That's the thing—the whole field. We took into consideration the various parts of it locally.

Q. I understand that perfectly, but the various parts that you did take into consideration have the self same diverse characteristics that you have been talking about, that's the only thing I'm asking.

A They do have diverse characteristics and in the method we used locally, we weighted them out by grouping the areas.

Q. You weighted them out by averaging them?

A Well, I suppose you can call it averaging if you want to.

Mr March: By that you mean an arithmetical average?

The Witness: Well we grouped them and took the—

Mr. March: Or weighted average?

The Witness: The weighted average, that's what it was.

Mr. March: As distinguished from an arithmetical average?

The Witness: That's right, a weighted average.

Mr. Keffer: Is that all?

Mr. March: Yes: I beg your pardon.

Mr. Keffer: That's all right.

Q. The weighted average is, of course, as you have already described many times?

A. Yes, sir.

Q. You could have done that for the field as a whole, couldn't you?

A. You couldn't have—no, I wouldn't say you could. You couldn't have applied the—and that's just the point I want to make. You couldn't have applied the characteristics of Moore County and weighted them against the characteristics of Wheeler County, for example, and have got a correct answer for either one.

Q. All right, why not just cut off Wheeler County and figure the two separately?

A. Well, I think as far as Wheeler County is concerned, we took into consideration the local variations and they were weighted out.

Q. All right. Now, we have spent a lot of time on that, Mr. Hammer, and I am going to move on.

As a matter of fact, how do you know you couldn't apply it to the field as a whole? Did you make any effort to?

A. Yes, I made an effort to.

Q. What figure did you get when you did that?

A. I don't remember that. I know it was a figure that —well, I just did it roughly in about an hour one morning.

Q. An hour?

A. Yes, with some figures I had, and it seemed to me that it wouldn't give—well, I just felt that it wasn't right.

Q. It just didn't give you the answer you were looking for?

A. That is not true at all.

Q. Didn't it give you substantially less than you got when you hit upon these quadrants?

A. No.

Q. It didn't?

A. I don't believe it did. I don't remember the figure. I just say I decided that this was the better way to do it and I have stated why I thought it was a better way to do it.

Q. I know you have, but my question is, when you disregard your quadrants and figured the field as a whole you got a substantially less figure than you did when you set up those quadrants and figured them in and then totaled up *you* quadrants. I am asking you that pointed question.

A. As I say, I don't recall what the figure was.

Q. Will you look in your working papers and find out what your figure was?

A. No, as I say, I threw that in the waste basket.

Q. Threw what in the waste basket?

A. What little calculation I had. I didn't even consider it.

Q. Well, how do you know it was wrong?

A. Because we decided that we would get a whole lot more accurate answer—

Q. How did you know what was an accurate answer?

A. Well, we decided we would get a whole lot more accurate answer if we worked the thing out by the local characteristics from one and to the other and then took the summation of those, and that is what we did.

Q. And you didn't even check by applying it to the field as a whole to see if there would be any difference in your answers?

A. Not in general; no.

Q. You didn't check it by any other method?

A. No.

Q. You just shut your eyes to everything except just what you did here?

A. We used this method throughout.

The Trial Examiner: What process, Mr. Hammer, did you go through to make this calculation?

The Witness: Oh, I just had a few figures and I said, "Well, if such and such were true, such and such would be true," and I said, "Well, after all, it seems to me that here we have a great field 120 miles long with all sorts of

characteristics from one end to the other, variables in potential, variables in production per acre pound decline, variables in regional sand characteristics, and if you tried to weight out or utilize the whole field, that would never get a figure that you could apply locally to determine the reserves in any given area that would mean anything."

The Trial Examiner: Well, now, if through a matter of curiosity the Examiner decided that he would calculate the reserves in this field on the basis of the whole field, are there figures now in the record which the Examiner could take and make the calculation that you have just stated you have made?

The Witness: —I believe—well, I wouldn't want to say. I would have to look to check. May I see that sheet, please?

(The document referred to was passed to the witness.)

No, I don't believe they are.

Mr. March: By that you don't mean to say that you haven't presented an exhibit which shows the reserves in the whole field?

The Witness: No.

Mr. March: You have an exhibit which shows the reserves of the entire field, the exhibit marked for identification as Exhibit 186?

The Witness: That's right.

Mr. March: But what you are trying to say is—as I see what the Examiner is getting at is this: that could he take your figures as you have them here in your exhibit and apply another method which would be to take the whole field as a whole, without disregarding all quadrants and arrive at an answer.

The Witness: No, I don't have.

Mr. March: He might arrive at some figures but the figure in your opinion that he would arrive at would be an unsound method and be inaccurate?

The Witness: That is my opinion.

Mr. March: Here is the thing, the witness was asked about the Phillips Petroleum Company and he answered the question.

Mr. Keffer: Who asked him about Phillips?

Mr. March: You did.

Mr. Keffer: He volunteered the statement. I asked him nothing about it. The statement was volunteered on that.

Mr. March: We'll check the record on that.

Mr. Keffer: All right, check it.

Mr. March: The Examiner will remember distinctly that it was agreed by both Mr. Hammer and Mr. Keffer that there was a difference in the application of the quadrants. That type of method was not used in the Phillips—

Mr. Keffer: Let's stay with the record. There was nothing said about any quadrant being used.

Mr. Spencer: Mr. Examiner, perhaps we can shorten this. Let me ask you this, Mr. Hammer: If you handed back to us your working papers on the entire field, we would then have sufficient data to take, to make that computation?

The Witness: I do not have them here. The only working papers that I have is the tabulation that I turned in. I don't even have the working papers for the entire field, I mean outside of the working papers that you have already had.

Mr. Spencer: If you will hand us back the working papers that you gave us prior to the commencement of your cross examination, we will attempt to supply the Examiner with the figure from his working papers that you were asking about.

The Trial Examiner: I don't know that it is necessary, Mr. Spencer. I was merely curious to determine whether or not I could make that calculation on the basis of the figures that are contained in these present exhibits and not a necessary or important thing so far as the Examiner is concerned.

Mr. Spencer: I would put it on this basis: I have more than curiosity on it. I would like to do it.

Mr. March: As a matter of fact, you have already started to do it, haven't you?

Mr. Spencer: You can read my mind pretty well, Mr. March, but not quite that well.

The Witness: Mr. Spencer, may I suggest this: You will recall that I had some difficulty trying to find the tabulations that I turned in. Now, before you go to that trouble or ask anybody else, let me have a chance to search and see if I do have. Now, I don't know that I do have.

Mr. Spencer: That's all right.

Mr. Keffer: Are you through, Mr. March?

Mr. March: Certainly. Pardon me, Mr. Keffer.

By Mr. Keffer:

Q. Mr. Hammer, regardless of the merits or demerits of the pressure decline method, if you take the whole field as a whole, then there would be no question of balancing one quadrant against another in many different groupings and in many different combinations in determining drainage and things of that sort?

A. Read the question, please.

(The question referred to was read by the reporter, as set forth above.)

The Witness: Well, as far as the question of drainage is concerned, I previously testified that I have not made a particular study of the drainage.

By Mr. Keffer:

Q. That's right. Now, just a moment, there. You did say that was the reason you had to balance one quadrant against another, to adjust drainage in and out.

A. Local, yes, but not drainage for the entire field as a whole.

Q. What's the difference, if there is drainage, whether it is local or regional?

A. A big difference.

Q. All right, if you think there is a difference we will let it stand there, but regardless of that, if you had taken the field as a whole, all of those questions certainly would

have been eliminated because there was no drainage into the field or out of the field.

A. Well, I would agree with you that if you had taken it that way that that might have been true.

Q. It would absolutely be true?

A. All right.

Q. Do you want to cut the "might" out of your answer?

A. No, I think I'll let it stay there.

Q. All right. Well, now, Mr. Hammer, in computing your reserves I believe you stated you had to have production figures?

A. That's right.

Q. Even in that one hour's calculation you had to have some production figures to make that one, didn't you?

A. That's right.

Q. And you got those figures, I believe, from the Texas Railroad Commission?

A. Yes, they were taken from the records of the Commission.

Q. But at the time you—well, I'll ask you this: Do you know to what extent that those records might have been incomplete?

A. From 1935 on I think they were quite complete.

Q. They were complete as to metered gas?

A. That's right.

Q. You do know that gas is used in flowing wells?

A. That's right.

Q. Gas is lost in drilling wells?

A. That's right.

Q. And various losses of gas of that character which is not reported to the Railroad Commission?

A. I think that is true.

Q. That's right. What is reported is the metered production?

A. That's right.

Q. All right, don't you think it might have been well to have made some inquiry to determine about how much of that gas was going that way, for the sake of accuracy in your figures?

A. Well, it might have been advisable, but after you had done it you couldn't be at all sure of the figures. It wasn't metered. It would be someone's guess.

Q. I appreciate that, but couldn't you have made a conservative guess on it? You knew it was something.

A. I doubt if you can make a conservative guess on an area as large as that. The point there, Mr. Keffer, is this, that the very fact that we didn't utilize that wasted gas is an added factor why our reserve tends to be a minimum reserve.

Q. That could be very true, but it might show some other things, too, mightn't it, Mr. Hammer?

A. I don't think it would show anything. In other words, the percentage of gas that has been wasted over the last five years and utilized for other purposes than unmetered gas would be so small in relation to the whole that it wouldn't be important. Now, prior to 1935 that's a different story.

Q. But you didn't consider any of it prior to 1935?

A. Well, I didn't consider anything prior to 1935.

Q. That's right, you started with 1935?

A. That's right.

Q. But if those factors, had they been considered, would have developed some other matters pertinent, do you think it would be certainly permissible for us to take that into account, wouldn't you?

A. What things are you talking about?

Q. This gas that you didn't take into consideration that went into the air, and unmetered.

A. I don't understand the question.

(The question referred to was read by the reporter, as set forth above.)

The Witness: Well, I am not judging what you may take into account in your consideration.

By Mr. Keffer:

Q. Oh, I understand, but you as a geologist wouldn't say that would be farfetched?

A. I would say it would be better if you had them, but not being able to have them and making an estimate or a guess from this fellow and another fellow, you might get four or five different fellows and get four or five different answers.

Q. You looked at that sort of like dry holes in as much

as you don't know of more than six inches being dry, you just ignored it.

A. Yes, realizing when I did ignore it that it would have a tendency not to inflate the reserve factor.

Q. You have the acre factor; you have to multiply the acres, it would have to some extent.

A. No.

Q. Now, Mr. Hammer, during the pariod from 1935 to 1939 there were some wells that were not connected to gasoline plants that were producing casing head gas and blowing it into the air. Did you make any investigation of that?

A. During the years 1935 to 1939?

Q. Yes, in the gas area.

A. No specific investigation of gas blown, because—

Q. If there was any of that you have ignored that?

A. We were informed by the engineers of the Texas Railroad Commission that while in the early part of 1935 and running on, we will say, into 1936, there was, but that practice by the time 1938 or 1939 came about had largely ceased to exist.

Q. Well, it was very much less but it still existed to some extent, didn't it?

A. Well, that is all right—no, again that would be a guess.

Q. In other words, you more or less assumed it didn't exist and didn't make any particular investigation of it?

A. I think that is true.

Q. All right.

A. If that is true that would give us a factor that would tend to reduce the estimate of reserve.

Q. That might be very true, but again I say it might show some other things also?

A. I don't know as to that. I doubt it.

Q. All right. I believe you have already stated that you did not obtain any figures for gas used for fuel and drilling operations?

A. Metered gas reported to the Commission was what we used.

Q. Ordinarily gas used for drilling operations is not metered, is it, unless you are buying it from some other producer?

A. I don't know what the practice is. If you buy from another producer, unless you buy it on a flat rate basis, it is metered.

Q. That is right. Frequently that happens, it being charged for at the rate of so much per day?

A. That is sometimes done.

Q. It is so much on a rotary operation and so much on a standard operation?

A. Sometimes it is metered.

Q. Sometimes it is metered?

A. Yes.

Q. And I take it you made no particular inquiry into that?

A. No, we didn't use that figure.

Q. Did you make any inquiry as to what it was?

A. I think we have seen some figures, maybe, during one year or two that somebody had estimated, estimating the amount of gas for those purposes, but as a general thing we didn't try to get it.

Q. If you had all of those volumes of gas and knew pretty well what they were and you were deducting that from the original reserve as you found it, you would have a smaller figure than deducting the figures which you have compiled, wouldn't you?

A. If I deducted—you mean—

Q. Just as a matter of subtraction.

A. From the original?

Q. From the original.

A. Yes, you would have a smaller figure.

Q. That way you could give a lesser figure rather than a higher figure for remaining gas reserves?

A. That isn't the method we used.

Q. I appreciate that, but maybe somebody might use the other method, and I want the record to show this gas and your omission of it. That is all.

A. Your statement under that condition, if you had a lesser amount that actually came out of the ground, it would make a difference.

Q. All right, now, would it interest you to know that in 1935 gas blown into the air, gas used in drilling, casing head gas not treated and blown into the air, ran as high as seven per cent of the total field production?

A. It would be interesting, but may I ask this: What percentage of that came from the area in which the Canadian River's acreage is situated?

Q. We are talking about the field-wide figure.

A. I would be interested more to know what percentage of that gas came out of those quadrants in which Canadian River Gas Company has its acreage.

Q. Well, what makes a difference where it came from? It came from the reservoir, didn't it?

A. It makes a lot of difference.

* * * * *

The witness stated that he was pretty certain there had been more drilling in Moore and Potter Counties in recent years than in other portions of the field and that usually when there is more drilling you have more production and that as you have more production you have more rapid pressure declines in the future that you had in the past, and that he would expect the pressure decline in Moore and Potter Counties to accelerate.

The witness was then asked that if you had a pressure decline of so much per year for the past five years that this is not very positive proof that there is not going to be a greater pressure decline for the next five years, or any number of years in the future, and he answered that he was not endowed with power to look into the future to see what would happen.

The witness then stated that if he had factual data for another five years perhaps his present estimate would be altered.

The witness stated that when an averaging process was utilized, whether in a quadrant or in the field as a whole, in which areas of prolific production are averaged with areas of lean production, you get a false answer if the variations are very great. If you have absolutely the accurate pressure at a given date, and you have the given pressure at another date, and you have the volume of production during that intervening period, you have all of the tools you need to apply the pressure decline method. If the conditions were ideal you would get the same production per pound loss in pressure for any given period. If you had a reservoir where there was no factor of permeability, such as a room full of gas and draw it out, you would be approaching ideal conditions but those conditions do not exist in the Texas Panhandle Field. The witness stated, however, the pressure decline method might be utilized notwithstanding the absence

of ideal conditions because the divergent conditions were all weighted out.

The witness did not agree that if you got a different rate of production for every pound lost in pressure for each period that this demonstrated that the pressure decline method was not working properly, but said you would get the same answer every time if you had a fully developed field where every one of the wells was finished. You would have a better condition and would get a better answer. He acknowledges that his estimate is not perfect, but does think it is the best method and approaches more clearly the true condition than any other method of estimating reserves.

It is his opinion that if the basic data is correct, there is not going to be any great variation in the estimates from year to year as compared to production and pressure drops.

Every time you drill in a new well you get an added pressure, that is, an added pressure point you never had before. You also get an added potential that you never had before. You start taking gas out and you get an added volume of gas, and as time goes on you do have these changes, but they should weight out very closely in the method I have employed.

If you computed the reserves last year, for example, and got the correct answer, then you could drill wells from now on until "dooms day" and that answer wouldn't change if everything was perfect, that is, if you had an ideal situation.

The witness realizes that a slightly different answer is obtained each year that the pressure decline method is applied, but states that you cannot take one year or two years in the Texas Panhandle Field and even hope to use the pressure decline method. You must have a longer period, and the longer the period the better, and it will not be long until you will obtain a curve that will stand up throughout the life of the field. ~~We have not rea~~ched that situation yet because there are certain areas that have not been drilled. This has an important bearing. If a well is drilled in a 435 pound area and you start producing gas, a new condition locally is created which will have its effect. It gives you another factor and the application of it will give you a more nearly correct answer. It is the witness' opinion, however, that the undrilled acreage that has a pressure of 430 pounds

is relatively unimportant when compared with the field as a whole.

The highest pressures at this time are in Moore and Hartley Counties, all along the southwestern part of the field and up around the western portion until you get near the northern part of Moore County, all around the edges.

Going all along the southern line of the field, starting from Wheeler County, going west and including an area along the edges of the field, back several miles, and continuing until you reach the northern tip of Moore County, a distance of probably 175 miles, you have an area of high pressure in general—much higher than an average of the field as a whole, which includes all of the area which witness admits is of doubtful productivity. That is, the area in question includes the area in which the volume of gas in place is doubtful—an area of doubtful productivity, and it also includes the area of high pressure.

The witness then testified with respect to the weighting process he used in determining the average weighted pressures and explained what he meant in stating that all of the diverse factors were weighted out in his process. He did this by taking the area between each of the isobars in a given area. He computed the area as accurately as he could and then took the average pressure for the area between two of the isobars and mutiplied the average pressure by the area. He then took the summation and divided that sum by the total acreage in a quadrant, and when he did that he got an average weighted pressure for the quadrant.

This was illustrated by referring to Quadrant 1, Potter County. The area included within the 430 pound isobar lines was computed as to acres and the number of acres in this area was multiplied by 430. The 430 pound acreage is in the southern part of the quadrant. He made the same computation for the area between the 360 and 370 pound isobar lines in the northern part of the quadrant. He determined the acreage in this particular segment and multiplied the pressure obtained by the number of acres, but refused to state that he got a bigger product, acre for acre, in the 430 pound zone than he did in the 360 to 370 pound zone. This was then illustrated by assuming that the northernmost area which lay between isobar lines 380 and 370 contained 1,000

acres, and that the average pressure in the area was 375 pounds. This 375 multiplied by 1,000 would give 375,000 as a factor. The southernmost segment which had a pressure entirely above 430 was also assumed to contain 1,000 acres, and he arrived at his factor by multiplying 430 by 1,000 and got 430,000. The witness said that this is what he did.

He was then asked which segment contributed the most weight acre for acre, the north or south. He answered that neither one contributed more than the other but stated that they both contributed the same notwithstanding the fact that after his arithmetical process had been completed one had a factor of 375,000 and the other 430,000, but he said that when you add all of these up and divide by the total acreage, then balance these against the entire acreage, you would get an average figure for all of them. The average pressure in the illustration given would be 402½ pounds weighted average pressure in accordance with the witness' method of averaging, being 375,000 plus 430,000 divided by 2,000, the total acreage. The witness insisted however that neither segment contributed more than the other to the total weighted average because the inconsistencies were weighted out by his method.

With further reference, by way of illustration, to Potter County, Quadrant 1, the southernmost segment in this quadrant contains a 430 pound pressure, while the northernmost segment lies between the 370 and 380 isobar lines, which gives an average pressure of 375 pounds. The weighting process utilized by witness was to multiply the acreage by the average pressure in each segment and then add up the products and divide by the total acreage in the quadrant to secure the total weighted average pressure for the quadrant, and the weight that was given the northern segment in the averaging process was the actual acreage times the actual rock pressure and that was true of every other segment in the quadrant, and the weight that was given the southern segment referred to in Quadrant 1 was the actual acreage times the actual rock pressure. The witness then stated, however, that this did not mean that the higher the pressure the more weight was given to the acreage in any particular segment, but again reiterated that as to each segment he multiplied the pressure by the

acreage, and that he did this for each segment in each particular quadrant, but again stated that it doesn't follow from this that the segment with the higher pressure contributes more to the total than the segment with the lowest pressure.

The witness then again outlined his method for determining weighted average pressure and that was by simply taking the areas in acres between the isobars and multiplying the acreage by the pressure which gave a pressure acreage factor. He then added or totaled all of these products for each segment in a quadrant and divided that figure by the total acreage in the quadrant which he said weighted the thing out completely and gave an average figure for the entire area in the quadrant. The procedure was then illustrated by assuming a quadrant contained a total of 2,000 acres, 1,000 acres having a pressure of 200 pounds, and the other segment, being the remaining 1,000 acres, having a pressure of 400 pounds. In order to get the average weighted pressure the 200 pound segment is multiplied by 1,000, giving 200,000, and the 400 pound segment is multiplied by 1,000, giving 400,000. This totaled 600,00. This was then divided by 2,000, the total average in the quadrant, which gave an average pressure of 300 pounds, and under this hypothetical case, the 400 pound segment contributed just twice as much in the weighting process as the 200 pound segment. The witness further stated, however, that this gave an erroneous figure, but if they are cut down to 10 pound differentials in pressure the error could not be more than 5 pounds.

The matter was then illustrated by assuming a quadrant with a 10 pound pressure differential, each segment containing 1,000 acres and ranging from 200 pounds to 400 pounds with 10 pound differentials all the way through, that is, starting at the lowest, 200 pounds with 1,000 acres, 210 pounds with 1,000 acres, 220 pounds with 1,000 acres, and so forth in the same manner until 400 pounds is reached, which also contains 1,000 acres. The witness then figured all the way through and arrived at the weighted average pressure by multiplying the pressure in each segment by 1,000 acres, being the area of each segment, then totaling the various products and dividing by the total acreage in the quadrant in order to get his total weighted

average pressure. By this method of calculation, which was the method used by the witness in making his reserve estimates, it was demonstrated that the 200 pound segment contributed 200 times 1,000, or 200,000 in the weighting process, and the 400 pound segment contributed 400 times 1,000, or 400,000 in the weighting process.

The witness stated that of course if you consider only the two segments you would have a distorted figure for the reason that one would have contributed twice as much as the other, but this had no application to the actual problem because he didn't take just two segments in making his reserve estimate but averaged all of them, from 200 to 400, and got a weighted average figure and in this manner assigned the same value to all of them, and thus weighted the entire error out of it. He says that when each segment was considered as above outlined, one segment had no more effect upon the final answer than any other segment because they each had the same value after he had averaged or weighted the various factors for each as stated. He was then asked if the 210 pound segment didn't contribute a little more to the final answer than the 200 pound segment, and the 220 pound segment a little more than the 210 pound segment, and so on all the way up the scale to the 400 pound segment, and he stated that that was correct, but again stated that notwithstanding this the 400 pound segment did not contribute twice as much as the 200 pound segment because they were weighted in with all of the other segments.

Quadrant 1, Potter County was again referred to for illustration. The witness stated that the northern segment of Quadrant 1 had 270 pounds pressure and the southern segment 430 pounds pressure, which is shown by map, Exhibit 179. The witness was then asked whether, if, as a matter of fact, the 270 to 280 pound segment in this quadrant was highly productive, and the 430 pound segment right down on the edge of the field in the southern part of the quadrant was very lean, this would not result in unduly stressing the lean acreage. He said this was not true because in considering all of the intervening segments he had weighted out the difference and flattened out the pressures for the entire quadrant. He stated it was true that even in this process the southernmost segment

(which was assumed to be lean) counted much more, acre for acre, than the northernmost segment (which was assumed to be rich) but that when all of them were averaged in they were all weighted out and had the same value.

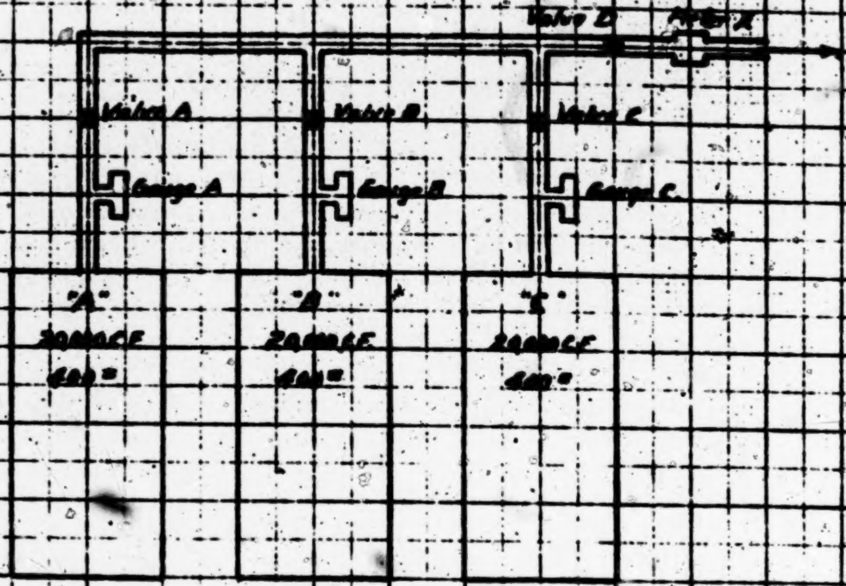
He was then asked if his answer would not be correct only on the theory that the acre content of the gas in place was just the same in each segment because then if this were true he would get a correct average, but only if this were true, and that in that case of course the 400 pound segment would be given just twice as much weight as the 200 pound segment, but would be entitled to just twice as much because the original acre content was just the same and the pressure was twice as great. The witness stated, however, that this was not correct and said it would work even if you had drilled a dry hole in some of the acreage because this was all weighted out in considering each of the segments as hereinabove explained. He stated that in other words, you simply took the high pressure area and balanced it against the low pressure area, and the low and balanced it against the high, and got the weighted average.

The witness was then asked that in the application of the pressure decline method if he applied it and got a certain pound drop in pressure for so many billion feet of production which came mostly from the rich areas of the field, and then averaged that in with the lean areas that had a high pressure, but which had had no production and had not been affected by drainage, that this would necessarily give him a distorted figure. He answered that you would not get a distorted figure because the high pressure areas had been averaged in with the more prolific lower pressure areas in the balancing and weighting process as above outlined.

There was marked for identification Exhibit 188 which was later received in evidence.

For Demonstrating Pressure-Decline Method

Chart 1.



Total Assumed Quantity of Gas

Container	"A"	20,000 C.F.
"	"B"	20,000 "
"	"C"	20,000 "
	Total	60,000 "

In the accompanying examples all pressures are assumed to be absolute, deviation from Boyle's law is ignored, and the space in the connecting lines, gauges, and meter is considered to be negligible.

C. Ron Hughes

Exhibit 188 is a drawing portraying three containers, each of which contains 20,000 cu. ft. of gas at 400 pounds pressure, and each contains the same surface area, assumed to be 1 acre. If 5,000 feet of gas were withdrawn from each of them this would reduce the pressure one-fourth in each of them. This would give a pressure of 300 pounds in each, which would be the weighted average pressure.

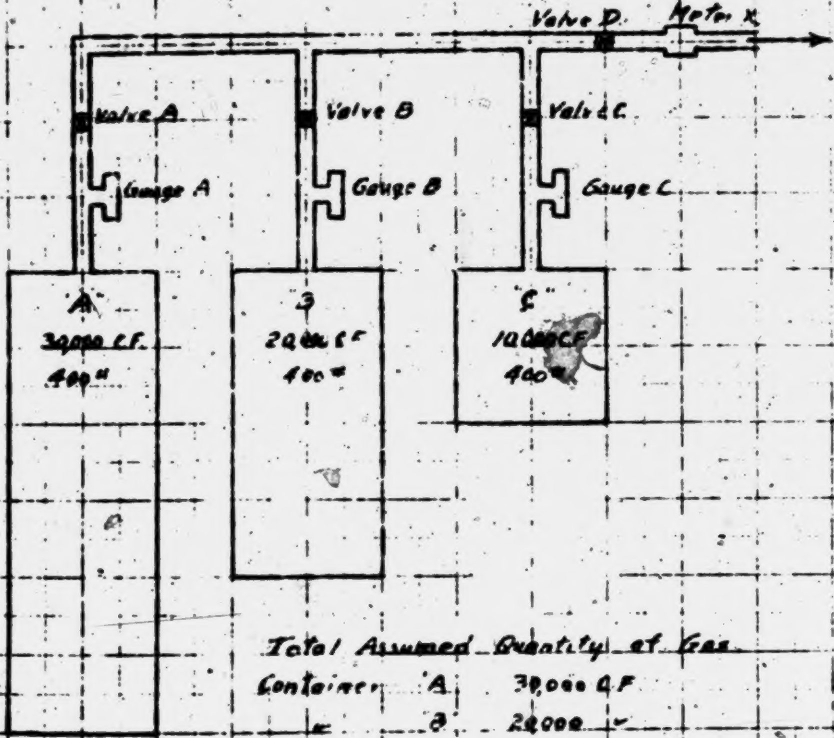
Still referring to Exhibit 188, the matter of pressure decline was again illustrated by producing the entire 15,000 feet of gas from Container A. It had 15,000 feet to begin with and would have 5,000 feet left. Three-fourths of the gas had been produced and, therefore, only one-fourth of the gas and one-fourth of the pressure would be left, or 100 lbs. pressure. The other two cylinders had no gas produced and were still at the original 400 pound pressure. The average pressure for the three would be 300 pounds. In producing 15,000 cubic feet of gas 100 pounds of pressure was left. Each pound of pressure lost represented, therefore, 150 cu. ft. of gas. There was a 400 pound pressure to start with. Therefore, to determine the original content 150 would have to be multiplied by 400 which would give a total of 60,000 cu. ft. This is the known original content in the three containers. This problem demonstrates that it doesn't make any difference how you take the gas out of the containers if the containers are all of equal size. It was the witness' thought, subject to further check, that you could take any other combination of containers of equal size and you would always come out with the same answer on the application of Boyle's Law. The containers, of course, represented a perfect condition and the answer was absolutely correct. It was the witness' opinion that it would work almost as well with respect to conditions that actually exist in the field, that is, if there was a variance in the acre content it would still work if the variance was weighted out just as he had done it and as he had theretofore explained.

There was then marked for identification Exhibit 189, which was later received in evidence.

Exhibit No. 189

For Demonstrating Pressure Decline Method

Chart 2.



Total Assumed Quantity of Gas

Container	A	30,000 C.F.
"	B	20,000 "
"	C	10,000 "
Total		60,000 "

In the accompanying examples all pressures are assumed to be absolute, deviation from Boyle's Law is ignored, and the space in the connecting lines, gauges and meter is considered to be negligible.

C. Dan Hughes.

Exhibit 189 illustrates 3 containers, A, B, and C, Container A having 30,000 cubic feet; Container B having 20,000 cubic feet; and Container C having 10,000 cubic feet. Each have a 400 pound pressure and each have the same areal surface, which was assumed to be an acre in each case. The witness stated that the variance in the Texas Panhandle Field as to acre content was certainly as great as the content assigned to each container and that, as a matter of fact, his investigation showed that the actual variance per acre content in the field was greater than that shown in the illustration.

Another illustration was then made with respect to the containers in Exhibit 189. This illustration assumed that 15,000 cubic feet were taken out of Container A, which left in it a pressure of 200 pounds. Nothing was taken out of the other two containers. The witness then arrived at an average weighted pressure for the three containers; that is, by taking the 200 pound weighted pressure in Container A, the 400 pound weighted pressure in Container B, and the 400 pound weighted pressure in Container C, the average weighted pressure would be 333 1/3 pounds. The original pressure in each container was 400 pounds, therefore, there was a total loss of 66 2/3 pounds in weighted average pressure. There had been 15,000 cubic feet of gas produced, or 225 cubic feet for each pound drop in pressure. It follows, therefore, that one pound of pressure represented 225 cubic feet of gas, and that in order to determine the original content in the three containers this 225 cubic feet would be multiplied by 400 which gives a total of 90,000 cubic feet as an estimate of the gas in place based upon the application of weighted average pressure to production.

As a matter of fact, the containers contained originally only 60,000 cubic feet, and therefore the estimate was just 50% greater than the actual volume of gas in place.

The witness stated that the error came about by reason of the fact that gas was withdrawn only from one of the containers, but he would like to have a little time to think the matter over.

Where the volume of gas was just the same in each of the containers the pressure decline method, or the appli-

cation of Boyle's Law, worked to perfection, but when the containers contained different volumes of gas and the average pressure was obtained by weighting one surface area, as in Exhibit 189, the pressure decline method, or Boyle's Law, gave an erroneous answer.

The witness stated, however, that in the example the weighting was unity against unity, but it was not always unity against unity in the field in so far as acreage was concerned. He said he used unity against unity, unity being quadrants, in estimating the field, but not in the sense that he was talking about, the difference being that you can only go out so far, and if you weight in acreage from which there has been no production, you are bound to get a lesser weighted production per acre pound than if you don't use it, but in making the estimate for the field the witness stated that he did weight in acreage that didn't have production and then upon being asked if that wasn't what was done in the example, he stated that he desired to reserve his answer.

The witness then stated, after a short recess, that he desired to make an additional explanation, and that was that the container example was not representative of the conditions in the field. If the three containers were connected, then it would approach field conditions, otherwise it would not be representative at all. The witness then stated that if the three containers were connected it would, in general, represent the conditions in the field.

Another example was then given. The containers were all connected as requested by the witness, and some gas taken out of each container. It was assumed that 15,000 cubic feet of gas was produced out of container A, 5,000 cubic feet out of Container B, and 2,000 cubic feet out of Container C. Each container was opened up and this was the total volume produced from the three containers, representing the field as a whole. The witness then solved this problem by determining the weighted average pressure on the three containers by weighting on areal surface alone as he did in making his reserve estimates. This indicated a weighted average pressure of 273.3 pounds, or a loss in pressure of 126 2/3 pounds. There had been a total aggregate production of 22,000 cubic feet, which resulted in 173 feet per pound loss of pressure. This then, multiplied by

400, the original equilibrium pressure, would result in a total estimate of gas in place of 69,200 cubic feet. The actual content was known to be 60,000 cubic feet. The estimate, therefore, was erroneous.

The witness then stated that instead of having three containers in the field, there were an infinite number of containers.

The witness then stated that the last problem represented a situation where the pressures were different in different areas and the quadrants were different with respect to the volume of gas in place in each quadrant, and that where this situation exists you can take any set of figures you desire and you will never get the right answer.

The witness then stated that the containers represented different reservoirs of certain sizes, which situation also existed in the field. It was then explained to the witness that the only difference in the illustration and the actual field condition was that the correct answer was known and advanced for the purpose of checking or testing the method where you have quadrants that vary as to productivity and where pressure differentials exist at the same time from one side of the field to the other. The witness stated that there was a further difference and that was that you have an infinity of reservoirs in the field.

The witness was then asked if the result would have been precisely the same if each container had been assumed to have 500,000 surface acres instead of one, thus giving the total acreage a figure that corresponded approximately with the total acreage in the field. The witness again stated that even under that situation that would still not take into consideration the infinity of reservoirs in the field. It was then called to the attention of the witness that there were wide areas in the field from which a single cubic foot of gas had never been produced and that this was shown by his Isobaric Map, Exhibit 179, and that was the basis for the first illustration given where some gas had not been produced from some of the containers. His attention was then called to the fact that the witness had stated in effect that the problem could be solved correctly if some gas was taken out of each container, and that a problem had been worked out on this basis but still an erroneous answer

had been reached. His attention was also called to the fact that the range in pressure in the example given, which was from 200 pounds to 320 pounds, constituted a much less differential than the actual differential existing in the field, and that the range per acre content only varied in the ratio of three to one, where the actual range in the field ran as high as six or seven to one, and that if actual field conditions had been taken, the answer would have been more erroneous than it was. The witness answered that he didn't think so, although he did say in this connection that actual pressures in the field ranged from about 90 to 430 pounds, and the per acre productivity was in excess of three to one.

The witness then was handed a set of calculations made from the witness' working papers and he was asked to verify the figures contained in the calculations. He could not verify the figures on the witness stand but stated that he would do so later. The witness did admit, however, that the basic figures from which the computations were made were all taken from his working papers. These calculations were later introduced in evidence and marked for identification as Exhibit 264.

Witness HAMMER further testified on cross examination, Vol. 58, pp. 8110 to 8253, inclusive, as follows:

The witness read into the record the weighted pressures for the entire field for the period from 1935 to 1939, inclusive, and also the total cumulative production during that period, which was as follows:

Year	Pressure	Cumulative Production
Aug. 1, 1935	369.25	
Aug. 1, 1936	360.74	615,778,940 Mcf.
Aug. 1, 1937	352.02	1,215,791,981 Mcf.
Aug. 1, 1938	343.01	1,832,231,200 Mcf.
Aug. 1, 1939	332.98	2,430,370,036 Mcf.

The witness stated that the pressure for each year was determined as of August 1 of that year, and that the production figures were from August 1 of one year to August 1 of the next. For example, the 1936 production figures represent the metered production from August 1, 1935, to August 1, 1936. The production figures were also cumulative for the period, that is to say, that the 1937 produc-

tion was added to the 1936 production and so on through the period, and that to obtain the production for any one year it would be necessary to subtract the cumulative figure from the next following cumulative figure. The pressure base was 14.65 pounds per square inch absolute, and the calculations did not include Wheeler County Quadrant 1. The total acreage for the field as determined by the planimeter calculation was 1,478,143 acres. The witness then stated that his estimate for the field of original gas in place, calculated to an assumed abandonment of 25 pound gauge at the well head, was 29,277,000,000 Mcf., but he had not calculated it to zero pounds well head, but stated that the original figure to zero pound well head could be determined by dividing the figure above given by 405 and multiplying the result obtained by 430, the original virgin pressure in the field, which would give approximately 31.046 trillion cubic feet of the original gas in place to zero pounds which would be all of the gas in place before there was any production on a 14.65 pound pressure base.

Witness HAMMER further testified (Vol. 58, pp. 8115-8141) as follows:

Before I get into that, let's go back again just a moment to the examples that we were working on yesterday. I will go back to the last example I gave you yesterday which was based upon Exhibit 189, being Chart 2 of the illustration demonstrating application of the pressure decline method. I believe on that last computation—

A. Just a moment. I will have to locate my papers.

Q. All right.

A. All right.

Q. Rather than the last illustration I gave you I think I will go back to the first one I gave you on that exhibit in order to facilitate the computation. The one I gave you on the spur of the moment figures out in some odd figures and it takes quite a little while to compute it, but I think this will illustrate the point just as well.

On that first one I gave you—

A. That is one hundred—

Q. I gave you two on 189; the first illustration was where all of the production was out of A, and the second one was where some of it was out of A, some of it was out of B,

and some of it was out of C. I am going back to the first one I gave you. That was 15,000 cubic feet production as I recall it, out of A, A alone, was it not?

A. I believe that is true.

Q. I am sure that is right. When you computed that out on the pressure decline method and weighted them through you got a total content of 90,000 cubic feet against a known content of 60,000 cubic feet, didn't you?

A. By your method of computation.

Q. And by your method, too?

A. No, I followed your method of computation.

Q. Was anything wrong with my computation?

A. Several things.

Q. I thought we had settled all of those things. What was wrong with it?

A. Well, now, we are referring to where you only take gas out of the one place?

Q. That is right.

A. Well, here is one thing that is wrong with it—

Q. How's that?

A. Here is one thing that is wrong with it—

Q. All right.

A. —and it is this: When a certain amount of gas is withdrawn from a cylinder the same *same* cubical content of gas remains in the cylinder but at a reduced pressure. In order to apply a 400-pound factor to calculate back to original volume it would be necessary to withdraw all of the gas from the container; the pressure decline would then be from 400 pounds to zero.

Now, in your case I didn't draw all of the gas out, and you utilized 400 pounds. What you should have utilized was your 200 pounds and you didn't do it.

Q. Do I understand—

A. In other words, you were using a factor to get your—it was about twice as large as it should have been.

Q. Will you explain what you mean by that?

A. I have just explained it. If you take the gas out of the container and you get your 200 pounds—

Q. That is right.

Mr. March: Go ahead and illustrate it. Go ahead and complete your answer.

The Witness: To use your 400 pounds you would have

to take all of the gas out because that is the total pressure originally in it. To use your 400 pounds you would have to take all of the gas out and multiply by 400.

By Mr. Keffer:

Q. You are trying to say you can't compute that until all of the gas is taken out?

A. No, not at all. What I am saying is that you used the wrong factor—it was just half the size you should have had.

Q. I started out with a 400-pound pressure all the way through.

A. Yes, you took out half of the gas and had 200 pounds left and then multiplied that by 400.

Q. Multiplied what by 400?

A. The amount of gas you had taken out.

Q. How is that?

A. The amount of gas you had taken out.

Q. Mr. Hammer, let's take that container. Let us assume that you don't know how much is in it to start with and you have taken out 15,000 feet and you have 200 pounds—you had 400 pounds pressure to start with and you have 200 pounds pressure left.

A. All right.

Q. You tell me how much was in there to start with. You don't know that and you are to calculate that from the tools I have given you.

A. Now, your statement was that I had 400 pounds to start with there?

Q. 400 pounds to start with.

A. And you take out gas enough to bring it down to 200 pounds?

Q. No, we took out 15,000 feet of gas and we took our pressures again and found they were 200 pounds.

A. All right.

Q. You tell me how much gas was in there to start with, calculated out just as though you didn't know the answer before you started.

A. Are you utilizing one cylinder alone and paying no attention to the others?

Q. No. A is the one I gave you.

A. Well, you have taken out 15,000 cubic feet.

Q. That is right. We agree on that.

A. You had a drop in pressure of 200 pounds.

Q. That is right.

A. You multiply that 15,000 by 2 and you get your 30,-000, your original—

Q. You do what?

A. You get your 30,000—wait a minute.

Q. Can't you figure that out in your head, Mr. Hammer, in about thirty seconds?

Mr. March: Now, Mr. Keffer, quit haranguing the witness. If you want him to figure out the problem, give him sufficient time to do so.

The Witness: I can't figure that out in any short time. If you will give me a little time I will do it.

By Mr. Keffer:

Q. Let me figure that for you. I believe I am better on those things than you are. We had 15,000 feet that went out of the area. We knew that as we have that figure. Isn't that true?

A. You took out 15,000.

Q. We knew we had 400 pounds to start with, didn't we?

A. That is right.

Q. We knew we had 200 pounds left, didn't we?

A. Yes, if you took out half of the gas.

Q. We knew we lost 200 pounds pressure, didn't we?

A. Yes.

Q. We knew for every pound of pressure left we had to produce 75 cubic feet of gas, didn't we?

A. That is 15,000 divided by 200.

Q. 15,000 divided by 200. We had 15,000 lost in cubic feet and 200 pounds lost in cubic feet and so it is just 200 divided into 15,000, isn't it? Is that 75 pounds or is it 750? Is that right?

A. I thought you had figured it out and I wasn't working on it.

Q. I will divide it out and see what it is. I may have left a cipher off.

A. It is 75 cubic feet.

Q All right. Then would we multiply that by—we would mutiply that by what to find the original content?

A. By the pressure of 400 pounds.

Q. By 400, wouldn't we?

A. Yes.

Q. And you would get what?

A. 30,000.

Q. So you do multiply by 400 after all, don't you?

A. Yes, under a condition like that.

Q. Yes, that is right.

A. That isn't analogous to our field problem.

Q. All right, we will get to that again. I thought we had covered that. That is a very simple application of Boyle's law?

A. For that application.

Q. And any high school student who had a very elementary course in physics could work that problem during an examination period, couldn't he?

A. Well, that statement is open to question.

Q. All right, we will let you question that one.

A. It is a problem in physics and not ordinary mathematics.

Q. How's that?

A. It is a problem in physics and not ordinary arithmetic.

Q. It is a problem in physics?

A. The only place physics comes into that is where you learn about Boyle's law, how Boyle's law applies.

Q. There isn't any question about the very simple problem we solved there, is there?

A. Not as it applies to the one cylinder.

Q. And we did have to multiply by 400 after all, didn't we?

A. For that particular case.

Q. That is right. So you want to retract the statement a while ago that when I multiplied by 400 I should have multiplied by 200; that was an erroneous statment, wasn't it?

A. Talking about this individual cylinder now?

Q. How's that?

A. Talking about this individual cylinder now?

Q. Yes, this individual cylinder—"quadrant," I believe is the name. I like that word better.

A. You can call it anything you want to.

Q. It my child; I can name it anything I want to.

A. I am still not sure—I would like to reserve my answer to your question.

Q. All right, how long do you want to reserve your answer, Mr. Hammer?

A. Well, I don't know. It will be just as soon as we have a five—or ten-minute recess so that I can get in a corner and figure it out.

Q. We will probably recess after while and then you can see if you can find a different answer to it.

Now, Mr. Hammer, let's take another very simple problem. You have this container here where you—this quadrant. I am going to insist upon it being called a quadrant—where you had a 400-pound pressure to start with. You know it has produced 15,000 cubic feet of gas, and you know you have 200 pounds of pressure left. Those are all definite figures and there isn't any estimate about them. Now, I want you to figure for me just how you would determine the remaining content of the gas in that quadrant. You have all the figures you need to determine that, haven't you?

A. You are talking about what?

Q. Just one cylinder, Quadrant A.

A. Well, you have to weight the problem against your acreage factor.

Q. All right, we will say it contains one acre or a hundred thousand acres or a million acres. You can compute any acreage you want to.

A. Will you read that question again, please?

(The question referred to was read by the reporter, as set forth above.)

The Witness: Now, let's get this problem straight.

By Mr. Keffer:

Q. All right, let's get it perfectly straight.

The Trial Examiner: Mr. Hammer, maybe I can help you.

The Witness: All right.

The Trial Examiner: On this previous computation you just made for Mr. Keffer I believe you arrived at what Mr.

Keffer seems to call "Quadrant A of reserves in place, the sum of 30,000 cubic feet original reserves in place." Now, you have produced 15,000 cubic feet and I believe Mr. Keffer's question is "what is the remaining reserves?"

Mr. Keffer: No, it isn't quite that. The question is, having those three known factors which I gave, that is, the original pressure, 400 pounds, the pressure of 200 pounds, the production of 15,000 cubic feet, then what would he do or how would he compute the remaining reserve today? He did that over the whole Panhandle field and I want to see how he did it on this particular area.

Mr. March: That is your assumption. You are taking this problem now.

Mr. Keffer: It is the principle that is involved.

The Witness: It isn't an analogous case, it is your problem, not mine.

Mr. March: We are working on your problem, these three cylinders, now.

Mr. Keffer: I want to have the witness tell me how much gas I have left there. I have to know that.

The Witness: Well, now, to zero, that is what you are after?

By Mr. Keffer:

Q. Remaining zero gas well head.
A. You would take out an additional 200 pounds—
Q. How's that?
A. An additional 200 pounds—I say, if you take out an additional 200 pounds of pressure—
Q. You wouldn't have anything left, would you?
A. That is right.
Q. Still you haven't answered my question. I am going to make a contract to serve Denver with gas when this present one expires and I want to know if I have enough gas there to do it. That is a very important problem to me and I want you to tell me as I have employed you as my geologist.
A. Well, if you are going to take all of your gas out of this one cylinder—

Q. Yes, that's all I have. That's the only reserve I have.

A. That all comes out of this one cylinder.

Q. That's right.

A. And you weight it against your one acre, your unity acre

Q. Yes, one acre or a hundred thousand acres. You can put any acre on it you want to.

A. On the decline there you would have just 15,000 cubic feet.

Q. We knew the answer to start with. I want to see the calculations that you go through to get that answer. Just explain briefly what you did to arrive at that 15,000.

A. Well, you do the same as you did in the first part of your withdrawal.

Q. Just give it to us step by step.

A. All right, when you draw out your 15,000, you had the drop of 200 pounds pressure.

Q. That's right.

A. Out of this one cylinder.

Q. That's right.

A. Then if you draw out all of it and get zero, assuming that you can get to zero, and you have taken out all the gas—

Q. That's right.

A. Why, you would have an additional drop of 200 pounds.

Q. That's right.

A. And at whatever pressure base you use in your calculation you would have the same 15,000 cubic feet.

Q. Now, is that the way you figured the Panhandle field?

A. Well, we figured the Panhandle field according to principles of Boyle's law, yes.

Q. Now, the only thing—that is the thing. You don't have to do any weighting here because you have got just the one quadrant. You don't have to do any weighting or balancing and the pressure is unifrom over the entire quadrant. Now, that is the only difference. I just saved you a little extra figuring there since you don't have anything to balance.

Now, that is the Panhandle field, we'll call it, and you

go ahead, step by step, and figure the remaining reserves there, just as you did in the Panhandle field precisely.

Mr. March: You haven't got enough tanks here, Mr. Keffer.

Mr. Keffer: Yes, we have.

Mr. March: You use several tanks—

The Witness: The whole point is you can't calculate the reserves of the whole Panhandle field or even part of it on that basis

By Mr. Keffer:

Q. All right, now, Mr. Hammer; then I have another field. If you don't want me to call it the Panhandle field, I'll call it some other field. I'll call it the Keffer field. I don't have one named for me, but maybe we can get one started.

Now, you have just figured the Panhandle field.

A. No, I haven't.

Q. How's that?

A. Not on your supposition I haven't figured anything.

Q. You gave us the figure you had arrived at for the Panhandle field.

A. But it wasn't arrived at by your method.

Q. All right. Now, we have this Keffer field here and you have just finished the job for the Power Commission on the Panhandle field and I have employed you to figure my field. Now, you go ahead and figure it. This is my field here and I have employed you. I want you to figure it using the same principles you used in figuring the Panhandle field.

A. I would have to have all your factual data. What is it?

Q. I just gave it to you. I had 400 pounds to start with. I have produced 15,000 feet. I have 200 pounds left. That's all you need, isn't it?

A. No, that isn't all you need in that.

Q. You can't figure it from that at all?

A. No, it isn't analogous. You recall that yesterday when we were discussing this same thing—

Q. Yes, I recall.

A. —I made the statement that in the Panhandle field that instead of one reservoir we had an infinity of reservoirs. You are talking about, and we proved yesterday in taking your three, that if you utilized just your three that you would only get 9,000 cubic feet above. Now, you go to work and add infinity of reservoirs to that and calculate it down, and as you approach infinity you will get the correct answer, but to take one reservoir and try to calculate it for the Panhandle field is absolutely impossible.

Q. All right, instead of putting one acre on that problem that I gave you, let's put 500,000 on each of them. That would be a million and a half acres and your figures on the Panhandle field is a million and some four hundred thousand odd. Let's put 500,000 acres on each one of them and then you will have that infinity, if that's what you called it there.

A. Yes.

Q. Would that make any difference?

A. You put 500,000 acres on what?

Q. On each one of those quadrants instead of just one acre.

A. You would still have your infinity of reservoirs regardless of how much you took.

Q. Sure. I got a million and a half acres and you had a million and four hundred thousand. I have more infinity than you have.

Mr. March: But you have still got three tanks, Mr. Keffer. That's right, isn't it? Do you want 500,000 tanks? We'll get down to business now.

Mr. Keffer: Just let him answer the question.

Mr. March: I am trying to clarify it.

The Witness: You have an infinite number of tanks—

By Mr. Keffer:

Q. What do you mean by an infinity of tanks?

A. Just what the word implies.

Q. I am not sure I know what it means.

A. So many that no one knows what they are, they approach infinity.

Q. I gave you a million. I gave you slightly more in acres when I gave you a million and a half acres, didn't I?

A. But that's a long ways from infinity.

Q. Well, but a million four hundred thousand is still further away from infinity, isn't it?

A. Well, yes.

Q. In other words, I am nearer infinity than you are when I gave you a million and a half acres, when your Panhandle field only had a million four hundred thousand some odd.

A. But in that extra million you had the added number of infinities on and beyond the million four hundred thousand; so all you have done is add a lot more infinitesimal spaces that didn't exist before.

Q. All right, what are those spaces?

A. Ordinarily, under any condition they would be the small reservoirs in which the gas exists.

Q. Well, I thought we had agreed way back—

A. In other words, it would be your porosity you are talking about.

Q. All right, supposing we put a little sand in these containers and create some porosity and permeability. Would you have any different answer?

A. Well, if you put some sand in this container you are talking about you couldn't have as much gas in there as you say you have.

Q. Well, take one where we will have the same amount of gas, then would that change the figure any?

A. Not as far as your reservoir is concerned because in your case you just have one.

Q. All right, now, Mr. Hammer, I didn't put any sand in that illustration to show porosity or any permeability because you said that didn't make a bit of difference on earth and you didn't figure any one of them when you were computing this acreage. Now, you have said that many times during this cross examination.

A. I said it was not necessary in the calculation. That hasn't anything to do with my statement.

Q. That's the reason I didn't put them in here.

A. I still adhere to my statement that you have an infinity of reservoirs and if you calculate by separate reservoirs as you have started out you will eventually approach the correct answer.

Q. All right, how many reservoirs did you figure in the Panhandle field when you applied your principle?

A. Actually each interval between the isobar lines for practical purposes is a separate reservoir. Now, if it had been possible and we had had maps big enough to have used one-pound isobars instead of ten, we would have very materially increased the separate tanks, you might say, that we would have utilized and we would have approached very much closer, or somewhat closer, at least, to the true figure than we now have.

Q. All right, now, Mr. Hammer, do you mean to say this: On the application of Boyle's law, that the bigger the reservoir and the greater the pressure differential the more accurate becomes the application of Boyle's law? Is that what you mean to say?

A. No, not at all.

Q. In fact, just the contrary is true, isn't it?

A. No, that is not true, either.

Q. Well, what is true, then?

A. Read that question.

(The question referred to was read by the reporter as set forth above.)

The Witness: No, that hasn't anything to do with it. Boyle's law. You can take any container, if it is large enough to calculate, and have the necessary known factors, and you can calculate Boyle's law.

By Mr. Keffer:

Q. Well, Mr. Hammer, do you mean to say that Boyle's law won't work in every instance regardless of the size of the container?

A. No, I didn't make any such implication.

Mr. Keffer: Well, read the answer that he gave. I guess I misunderstood him.

(The record referred to was read by the reporter, as set forth above.)

By Mr. Keffer:

Q. All right, do you mean to say that you have to have a big container to calculate Boyle's law?

A. That wasn't the intent of that at all.

Q. What was the intent, then?

A. Any given reservoir where you have a measured, a known pressure, and a measured volume of gas coming out, you can utilize Boyle's law.

Q. That's right, and that is precisely what we have had in every one of these illustrations, isn't it?

A. As far as a particular illustration is concerned.

Q. That's right. Does the principle ever change? Does Boyle's law become one thing on this illustration and something else on the Panhandle field or any other field?

A. Yes, as far as the field is concerned.

Q. All right, what does Boyle's law become, then, in some other field? What changes occur in the law?

A. No changes occur in the law at all. A change in the conditions—in other words, in the field. You are using one reservoir. In the field you have a multiplicity of reservoirs of different content.

Q. All right, now, do you say it works better where you have a lot of reservoirs than it does where there is just one?

A. As far as its application to the field is concerned, I wouldn't say it worked better, but we are talking about a practical thing.

Q. That's right, but where I gave you one container, where Boyle's law would have to work with one hundred per cent accuracy, as you take more and more containers and get diverse conditions in which you throw out of line, you might say, the application of Boyle's law, the more of those conditions the more accurate it becomes; now, isn't that correct?

A. Not—there would be some effect, but not where I have just stated a while ago. If we divide this thing into containers as we have, using 10-pound isobars, we are approaching awfully close.

Q. Well, you don't say that is as accurate as these illustrations as I gave here, do you?

A. I don't know of anything in actual practice in any sort of thing that is ever as accurate as a theoretical thing taken care of in a laboratory.

Q. You mean to say that the illustrations we have been working here aren't absolutely one hundred per cent accurate?

A. A theoretical thing of that type, yes.

Q. Well, practically—

A. Well, you could calculate Boyle's law there accurately by the condition you set up, certainly.

Q. You are trying to say that Boyle's law is some high-flown theory that doesn't amount to anything?

A. No, I wouldn't have used it—

Q. That's just the answer. Now, we have given you perfect conditions here for the operation of Boyle's law and it doesn't come out right, does it, as you have applied it to the Panhandle field under perfect conditions?

A. The point is, as I have repeated, you don't have one reservoir, you have a multiplicity.

Q. All right. I say, then, if we have a small reservoir anywhere, in the Panhandle field or anywhere it might be, which covered a thousand acres, you couldn't apply Boyle's law to it because you had just one reservoir?

A. Oh, yes, you could.

Q. All right, then, the fact that I used one reservoir in some of these illustrations doesn't make it any different, does it?

A. Well, it isn't pertinent to the field conditions.

Q. I think we agreed yesterday, Mr. Hammer, that when I gave you the problem that a certain portion of gas out of each of the three reservoirs that we show on Exhibit 189, that you agreed with me that the problem that I gave you was more favorable from your standpoint than the actual problem you had in the Panhandle field.

A. No, I never made any such statement. The record will show what I said.

Q. All right. The record will show this, that the variation in rock pressures on the problem that I gave you was less than actually exists in the Panhandle field. The record will show that, won't it?

A. What was that question, please?

(The question referred to was read by the reporter, as set forth above.)

The Witness: The variation in pressures?

By Mr. Keffer:

A. Yes, in your theoretical illustration, that's right.

Q. It was less. All right, and the content of the various reservoirs varied less than is actually true in the Panhandle field. In other words, you have a greater variation in the Panhandle field as content than we had in the illustration that I gave you?

A. Yes, that is true

Q. All right. Now, that being true, if it would not work on the illustration I gave you, how on earth could it work in the Panhandle field where the diversity is much greater?

A. All right. You go ahead and add, and start with 3, and 5, and 10, and 20, and a thousand and a hundred thousand and up into the trillions or maybe quadrillions of little reservoirs and apply your problem to it and you would get the right answer, but if you want to do that, that will give you the right answer.

Q. Well, I'll let you do it.

A. I have done too much of your figuring already.

Q. All right, now, let's take just another minute or two on this. I have used three quadrants. Let us assume that this were your Panhandle field. Your three quadrants, 1, 2 and 3 in Potter County, at the same time had the same variations which I gave you in the problem which we solved yesterday and you applied that to those three areas. Do you think you get the right answer?

A. As you have used it in this illustration?

Q. Taking the basic facts which I gave you—no, not as I used it, as you used it

Mr. March: You mean taking the cylinders, too?

Mr. Keffer: Well, I don't like to just play on words. We'll call this one cylinder A, if you want to call it that; this one cylinder B, and this one cylinder C (indicating).

The Witness: All right.

By Mr. Keffer:

Q. All right, the diversity between the three cylinders as to acre content and pressures is precisely as I gave it to you in that problem; then could you apply Boyle's law to that and get anywhere nearer the right answer than you got here?

A. Very much nearer, because this is divided into a whole series of containers as outlined by your isobars.

Q. All right. What is the occasion to have the isobars at all?

A. The isobars give you your variables in well head pressures.

Q. That's right. Now, if the variation—if you constructed your isobars to where you had three groups in which they varied just as I did in the problem here, then what would be the difference?

A. Read that, please.

(The question referred to was read by the reporter, as set forth above.)

The Witness: Well, the difference is that you are trying to apply an ideal theoretical condition there when as a matter of fact that condition does not exist in actual field conditions.

By Mr. Keffer:

Q. Now, Mr. Hammer, the only reason on earth that you draw your isobar lines and weight them in as you have explained many times is to get your weighted pressure, isn't it?

A. Yes, that is right.

Q. If you didn't have to get a weighted pressure you wouldn't have to have your isobar lines, would you?

A. That's right.

Q. All right, you had your weighted pressure here to start with. I gave you that to start with, didn't I, in the problem we have been working?

A. That's right.

Q. There would be no occasion to draw any isobar lines on this because you have your weighted average to start with.

A. That's right, in your picture.

Q. Then why talk about your isobar lines, because if you drew isobar lines the only thing you would be working to would be the very thing that you started with?

A. That's true as far as your cylinder is concerned, but it doesn't apply to the field condition.

Q. Now, Mr. Hammer, as a matter of fact, your pressure decline method will work properly, if the pressures of your field were uniform, won't it?

A. It will work properly under conditions under which it has been working.

Q. Well, answer my question.

A. If you had ideal conditions, yes.

Q. If you shut the Panhandle field in and let the pressures equalize and then apply your Boyle's law, then you get the right answer, approximately, wouldn't you?

A. You would get a close answer, yes. You would probably get the best answer, I will say that.

Q. Or if the entire field was of equal productivity, every portion of it, and every area of it and you applied Boyle's law you would get the right answer, wouldn't you?

A. That is not necessary.

Q. Wouldn't you get the right answer?

A. If you had that condition.

Q. But neither one of those conditions exists in the Panhandle field, do they?

A. That is true.

The witness was then referred to some figures in Exhibit 182 which were compiled by Commission Witness Stevens, and he stated that the pressure decline, as determined by Stevens on an arithmetical average of wells as to the quadrants in which Canadian River owned acreage, was 15.6 pounds from midyear 1938 to midyear 1939, and on this basis the life expectancy of the Canadian River reserves would last for 21.3 years from August 1, 1939, to a 25 pound abandonment pressure. He stated, however, that this exhibit was predicated upon the volume of gas that each well would produce, and it was his opinion that the present wells would not produce the entire volume of gas now in place.

Gas will migrate more rapidly under similar conditions as to permeability at high pressure differentials than it will at low pressure differentials. The witness was then asked if it wouldn't be possible for gas to migrate more rapidly with low pressure differentials where the permeability was high than it would in the case of high pressure differentials where the permeability was low. He stated that the question of infinity of conditions again comes into play, and it is a difficult question to answer for that reason, but that it is possible to have a situation where the formation is so permeable that gas will migrate from one part

to the other with practically no pressure differential. Gas will migrate more rapidly through a 50% permeable formation with a 10-pound pressure differential than it will through a 10% permeable formation and a 10-pound pressure differential.

The witness stated that the lowest pressures in the Texas Panhandle Field exist along the northeast side of the field and that this is due to heavy gas withdrawals in that area. There is no particular water drive in the Texas Panhandle Gas Field.

The area around Borger and Sanford, in Hutchinson County, which is in Quadrants 2 and 3 in Hutchinson County, presents a situation where the pressures have remained approximately stationary over the five-year period studied by the witness. However, the average for Quadrant 3 shows a decline by reason of the fact that it extends northward into a high pressure area in which pressures are declining.

If an area is increasing in pressure while it is producing substantial volumes of gas, the only logical conclusion to make is that such area is receiving gas from other areas by drainage, and the same thing is true for areas where the pressure is declining but where the decline in pressure is not as rapid as related to the total amount of production as was true in the earlier producing history of the wells. In other words, this would indicate either drainage into the area or water encroachment which was reducing the size of the reservoir, but the witness stated that in his opinion there is no water encroachment in the Texas Panhandle Gas Field. If there was, Boyle's Law could not be applied at all, and if there was just a little water encroachment or water drive this would throw you off to some extent in the application of Boyle's Law.

The witness did not know that after the carbon black law was passed, that is, the law which permitted sour gas to be utilized in the manufacture of carbon black, there was a very definite increase in the production of sour gas in Moore County. The witness, however, has not compared sour gas with sweet gas production on a reserve basis and does not know the difference in the sour gas portion of the field and the sweet gas portion of the field. His map,

however, does show the approximate division line between the two portions of the field. The witness was not interested either in the area with respect to sweet or sour gas.

The witness stated that if the sour gas area did not contain more than one-half of the acreage of the sweet gas area, and the production in the two areas was about the same, this would in time affect the sweet gas area and would in time have a tendency to set up a low pressure area in the sour gas area; that if production in northern Moore County continued at a higher rate than the production in the sweet gas area this would have a tendency necessarily to cause a migration of gas from the sweet gas area to the sour gas area. When the pressure differentials are set up this will have a tendency to cause the sweet gas to drain into the sour gas area.

The area just north of the Canadian River leases in Moore County has had a very intensive development. The extent of development of Canadian River's acreage has been about one well to 2,300 acres, while just to the north of the Canadian River acreage and adjacent, the development has been on the basis of about one well to every 640 acres.

Witness called attention to the fact that in an area embraced in Quadrant 1, Moore County, and Quadrant 3, Hutchinson County, Canadian River Gas Company has 30% of all of its wells located on 14% of its acreage, and for this reason he felt the Company was situated so as to amply protect itself from drainage. Witness also called attention to the fact that the Company proposed to drill some additional wells in this area.

The witness stated that notwithstanding the above, it still appeared that the pressures were higher on the Canadian River Wells in that area than were the pressures on the offsetting wells, and that notwithstanding the heavy production of Canadian River Gas Company in the area referred to, they were still unable to reduce the pressures on their leases sufficiently to prevent some drainage of gas away from their acreage to the north and northeast. The witness did insist, however, that this was a question of degree, but unquestionably there is drainage there. He didn't know how much, but it was his impression that it was not long distance or mass drainage, although he didn't know.

The witness further testified (Vol. 58, pp. 8178-8182) as follows:

Q. That's right. Even with those large number of wells that you speak of, of Canadian River Gas Company, located near the outside limits of their reserve, still the pressure on Canadian River wells in that very area you refer to is higher than the pressure on the offsetting wells to Canadian River reserve. Now, isn't that a fact?

A. Well, I would have to check.

Q. Let's check it right now. Here it is right here (indicating).

A. You mean isobars?

Q. Well—

A. I think the way to answer that is that the pressure according to this isobaric map in general is slightly lower to the north of your acreage.

Q. And to the northeast?

A. Yes, that is true as far as the map is concerned.

Q. All right. Notwithstanding the heavy production of Canadian River in the areas which you spoke of, they are still unable to reduce the pressures on their leases so as to prevent drainage of gas to the north and to the northeast? That is absolutely correct, not just approximately, isn't it?

A. Well, it is a question of degree.

Q. That wasn't my question.

A. Well, now, wait a minute.

Q. All right.

A. I'll answer your question. I said it is a question of degree and yet unquestionably there is some migration, but it is a question of degree of migration.

Q. That's right, you don't know how much?

A. No.

Q. You know there is some?

A. Yes.

Q. You know as a matter of fact that Canadian River, concentrating their production as they have in the area which you say they have, that if they were successful in preventing migration you wouldn't have the isobar lines stepping down ten pounds just consecutively one after the other toward the low pressure area, would you?

A. Well, unquestionably there is drainage there, but

it is my impression that it is not long distance or mass drainage.

Q. Just a minute. You said you didn't know.

A. I said it was my impression. You can have an impression without knowing.

Q. You still don't know, is that right?

A. I don't know anything about the volume and I don't believe anyone else does.

Q. Now, you don't want the Examiner to take your impressions on this, do you?

A. If you insist, Mr. Keffer, I will say that it is my opinion that there isn't any way to prove—

Q. Just how much drainage?

A. That's right.

Q. All right. Well, I think that's good enough. All right, now, you do know this, Mr. Hammer, that there is a great deal more gas per acre being produced adjacent to and just beyond Canadian River acreage in Quadrant 1, Moore County; Quadrant 2, Moore County; Quadrant 3, Hutchinson County, and Quadrant 4, Carson County, than is being produced from Canadian River acreage per acre, don't you?

A. Well, no, I don't know that.

Q. Well, didn't you check that?

A. I didn't segregate to find out. I wasn't interested in what the individual operators were producing.

Q. In other words, you weren't interested in whether we were suffering drainage or not, is that your position?

A. All I was after, Mr. Keffer, were the reserves of gas in place underneath your acreage as of a certain date.

Q. As of a certain date, regardless of drainage in or out?

A. Well, I said, as of a certain date.

Q. Well, that's all right. All right, now, the average weighted rock pressure of Canadian River acreage is much higher than it is for the field as a whole, you do know that? You had to find that out, didn't you?

A. Yes, I think that is correct.

Q. And greater than it is in the surrounding acres to the northeast and northwest?

A. Right.

Q. We are also agreed that gas migrates from high pressure areas to low pressure areas so that migration would necessarily have to come from whose land?

A. Well, you have got to go a step further.

Q. Sir?

A. You must go a step further to get a true picture. It is also true that there is a high pressure area to the north of this intensive area you are talking about, and gas, if it is coming at all, it is also coming in from the north.

Q. Into Canadian River?

A. No, into this low pressure area you are talking about.

Q. It may be coming both ways.

A. That is right.

Q. In fact, your map shows it certainly is coming from Canadian River.

A. Well, it also shows that it is coming in from the other direction.

Q. I don't know that I am prepared to agree with you. Regardless of that, I am talking of Canadian River. It shows definitely that it is flowing from Canadian River into that area.

A. But to paint a true picture, you have to have both sides of the picture.

Q. Not to show that we are losing gas. The fact that we are losing gas doesn't give us much consolation if Mr. Lange is also losing gas. We are still in a bad way, isn't that right?

A. That is true.

The witness then stated that although in his direct examination he had used the expression that the Canadian River reserves would last 73 years, this was intended simply as a statement of what would happen if conditions remained just as they are at this time.

Witness Hammer further testified (Vol. 58, p. 8187) as follows:

Q. All right, but this graph that you are talking about is consistent with your 73-year estimate, isn't it?

Mr. March: We object to that question—

The Witness: No, it is not.

By Mr. Keffer:

Q. I thought it was.

A. No, it isn't at all.

* * * * *

The witness further testified (Vol. 58, pp. 8190-8210) as follows:

By Mr. Keffer:

Q. Mr. Hammer, just as we recessed for the noon hour we were discussing I believe your Exhibit 180.

A. I believe that's right.

Q. Now, the three small points on that—Page 4B—

A. 4B?

Q. Yes, sir. The first point on that which represents approximately 425 pounds pressure, as I read it—

A. Slightly less than that.

Q. Not very much—do you know what it does represent?

A. I can tell you in a minute. It represents 422.7 pounds.

Q. 422.7. Now, what is that figure and where did you get it?

A. That is the weighted areal average pressure for the group of quadrants used in the determination of the factor 35.01 production per acre pound decline for application to Quadrant, Potter 3.

Q. Now, Quadrant 3, Potter County, I believe the record shows commenced production a long time before 1935, didn't it? This pressure was the pressure for 1935 as I take it.

A. That's right. Yes, this figure is 1935, that's right.

Q. Now, Quadrant 3, Potter County, came into production a long time before 1935, didn't it?

A. Well, I presume it did because there had been some production taken out.

Q. There had been some pressure drop?

A. Yes, there had been some pressure drop in that area.

Q. I will ask you if it had not come into production as early as 1928 or 1929.

A. I wouldn't know, Mr. Keffer, exactly.

Q. You didn't check as to that?

A. No, I didn't.

Q. Now, if it did come into production as much as six years earlier than what your line shows there, you would have virtually a straight line back from the line you do have for six periods, wouldn't you?

A. Read that question.

(The question referred to was read by the reporter, as set forth above.)

The Witness: Back to what year—1929?

By Mr. Keffer:

Q. 1929, that is what it would run to, yes.

A. Yes, I think that is true.

Q. All right, then, your curve, if you plotted that on your curves you show on Page 4B of your Exhibit 180, then you would have practically a straight line back to the left for as long a line as you have a dropping line to the right, wouldn't you?

A. Well, you know, as I said this morning, the actual question of time isn't the controlling factor in this. The controlling factor is the volume of gas removed.

Q. I appreciate that.

A. Regardless of time.

Q. But if you wanted to get an absolutely correct line, a graph from the time that quadrant came into production, you would for a period of five years have almost a straight line. It would be dropping a little bit, but not very much, until you got up to 1935, then it would be dropping more. You would have a line coming over sort of like that (illustrating), wouldn't you?

A. No, I don't think so.

Q. Why, it is so obvious, Mr. Hammer, I wish you would explain to me why you wouldn't have.

A. Well, you would have a straight line.

Q. Sir?

A. You would have a straight line.

Q. That is, a horizontal line, practically—not quite, but almost?

A. Horizontal?

Q. Yes.

A. No.

Q. It would be much more horizontal than the one you have plotted here.

A. No, I don't think that is true.

Q. In the same period, a five-year period, you go from 422 something—is that what you had?

A. Yes.

Q. —down to right at 400. You went down 22 points there, didn't you—a little more?

A. Yes, 402.8.

Q. According to your graph.

A. Yes.

Q. Then if you extended that graph on back to the time when the quadrant came into production, over a six-year period, you would have dropped only about seven pounds, wouldn't you?

A. Well, that just brings out the point I was talking about. Time doesn't enter into it.

Q. You would have had, wouldn't you—

A. Yes, if you do that, but time doesn't enter into it. It is the volume of gas taken out, regardless of time.

Q. What was the volume of gas taken out prior to 1935?

A. I don't know.

Q. It could have been a big volume so far as you know.

A. Yes, it could have been.

Q. That's right. Then if you were wanting to give absolutely an accurate picture you would have started back at the beginning instead of in the middle, wouldn't you?

A. No, not necessarily.

Q. You say the longer the period the more accurate your calculation, yet you didn't take as long a period as you could have taken.

A. I will say this, that if the data had been of such character that you could have utilized it with any degree of accuracy—

Q. What was wrong with the data in Quadrant 3, Potter County?

Mr. March: Let the witness finish.

Mr. Keffer: I think he had.

Mr. March: No, he was right in the middle.

The Witness: —that is just one of the several quadrants you utilized to arrive at the total reserve for Canadian River acreage.

By Mr. Keffer:

Q. Oh, I appreciate that. The question ~~I asked~~ you was what was wrong with the data on Quadrant 3. Please answer that simple question.

A. Well, it would be impossible to take one quadrant and go clear back when you couldn't get the data on all the rest of them.

Q. I know, Mr. Hammer, but if you will just answer my question we can get along much faster.

A. What was his question?

The Trial Examiner: What was wrong with the data on Quadrant 3, Moore County.

Mr. Keffer: No, Potter County.

The Witness: Well, the point is that we had a great group of acreage here. Now, if you couldn't get data back to the same point on all of them that were dependable it would have been useless to take it on one or two that might be dependable.

By Mr. Keffer:

Q. But you still haven't answered my question, Mr. Hammer.

A. Read the question.

(The question referred to was read by the reporter as set forth above.)

Mr. March: He has told you that. I want to bring it out in the record. He stated that his answer to that is that he couldn't get the data on all the rest of the quadrants, therefore, there wouldn't be any use, it would be impractical to take Quadrant 3 alone.

Mr. Spencer: You answered it just the same way he did, and just as well.

Mr. March: Thank you.

The Trial Examiner: The question pertains to the data in the particular quadrant, Mr. Hammer.

The Witness: Well, I don't have all of the data on Quadrant 3 back to the beginning as a separate quadrant. I only utilized that for the same period of time that we were forced to use all the rest of it. It might have been good. I think perhaps it was, but as I stated, it you couldn't get good data on all the areas that you could rely on it wouldn't do any good to take all the data on one of them.

By Mr. Keffer:

Q. Well, then, your answer is, I take it, that there was nothing wrong with the data on Quadrant 3 so far as you know?

A. So far as I know that is right.

Q. You have no reason to suspect that there was anything wrong with it?

A. That is right, as far as I know.

Q. All right. Now, that is the only quadrant you show, isn't it?

A. That's right.

Q. Now, you didn't go back to the beginning of production, then, on a single quadrant in which Canadian River Gas Company has acreage, did you?

A. You mean to the beginning of the life?

Q. That's right, the beginning of production.

A. No.

Q. Well, why didn't you do it?

A. I have just explained why I didn't do it.

Q. All right, was there anything wrong with the data on any of the Canadian River quadrants?

A. Well, I think Mr. Spencer will recall that there were a great many letters written to him during 1939 asking for this and that and the other thing. I feel relatively sure that after the work that we did in collecting data from the Railroad Commission in Texas plus the information we got from Mr. Spencer, I believe that we got a fairly accurate picture of the gas that came from all of the Canadian River acreage. I think we did.

Q. All right, the only picture you got is the different periods, the different markets, the different pressure bases that were used, isn't that the net result of it?

A. What was that question?

(The question referred to was read by the reporter as set forth above.)

The Witness: Well, I don't have all that data, but I do know that we got certain data from him and I do know that he told us in a letter that as near as he could give it to us that certain gas, and I believe he went to work and tied it down to particular wells as far as he could—as I re-

call it, he told us that the gas had been metered at four—I believe it was—four different pressure bases.

By Mr. Keffer:

Q. And gave you what those bases were?

A. That's right.

Q. Then, so far, at least, as Canadian River acreage is concerned you could have gone back to the beginning of production?

A. Yes, I could have done that.

Q. But you didn't do that because you couldn't do it for the field as a whole?

A. Not for the field as a whole but even in the areas where Canadian River has its acreage I couldn't do it.

Q. You couldn't have done it?

A. No.

Q. Which quadrant are you speaking about?

A. Well, I would say Quadrant 1, Moore County—

Q. All right, what was wrong with Quadrant 1, Moore County?

A. —and Quadrant 3 in Hutchinson County, and as I remember it, Quadrant 4 in Carson County.

Q. What was wrong with Quadrant 1 in Moore County?

A. Well, there have been a lot of wells drilled in there prior to 1935.

Q. Who drilled them?

A. Well, if I had time enough I could tell you who drilled them, but I think Canadian River drilled part of them.

Q. That's right, and you had all the information on them and—

A. Yes, I think that is right, on the Canadian River wells.

Q. Texoma drilled a few prior to 1935. You had the information on those, didn't you?

A. Yes, I think that is right.

Q. Wasn't that about all that was drilled before 1935 in that quadrant?

A. I would have to check. I don't remember.

Q. Well, would you say you could have gotten good information on Quadrant 1, Moore County, back to the beginning?

A. I wouldn't want to say. It is my remembrance—

Q. You just made no effort to determine, is that right?

A. Well, the whole point is that in the areas embraced in that part of the field where the Canadian River has its acreage there was so many records that weren't dependable that we just felt it was not—well, it was impossible to rely on them.

Q. All right, then, we'll go from that. This method of least squares that you have been utilizing, you could have a curve that goes up and down and up and down and up and down, peaks and valleys in it, and you could still straighten it out by that method, couldn't you?

A. That's right.

Q. If you had a curve that made an arc sort of like a half-dollar, the outer edges of it, you could straighten one of those out, couldn't you?

A. I never had occasion to apply it to a hyperbolic curve, no.

Q. It would work, wouldn't it?

A. I have never used that way. I suppose it might.

Q. In fact, it doesn't make any difference what kind of curve you have, you can always straighten them out by applying this least squares theory?

A. Well, I wouldn't want to go so far as to make a general statement of that kind.

Q. Where did you get that theory, Mr. Hammer?

A. Well, I knew that—I have known for a good many years that the method was applied to the projection of certain curves by—oh, statisticians and by certain chemical formula and general things of that type where the points did not—through which they wanted to draw a curve that did not fall in exactly a straight line and it has been utilized for that purpose.

Q. Well, I have seen lots of lines for long periods of time that weren't straight and I am wondering if this line ought to be straight, if in straightening it out you stayed with the tools which nature had given you up there to work out this problem.

A. Why, certainly it ought to be straight.

Q. How's that?

A. Certainly it ought to be straight.

Q. Ought to be?

A. Certainly.

Q. Why ought it to be straight?

A. Well, that is absolutely according to the principle of the Boyle's law. If you take out so much gas and you calculate your thing properly, why, you will get a straight line projection.

Q. Yet we didn't get it here, did we?

A. Oh, yes, we did.

Q. No, when you applied Boyle's law you didn't get a straight line. That's just what I'm talking about. You had to go to something else to get your straight line.

A. No, I didn't.

Q. All right, if you apply Boyle's law and plot your points there which you have, it wouldn't be the kind of a line you have got, would it?

A. Yes.

Q. Look on your map—on your graph and see if it would.

A. All right, which graph?

Q. The one on page 4B.

A. Yes, you would have a straight line.

Q. What makes it straight? If you are drawing from the center of one point to the center of another, do you have a straight line?

A. Oh, well, what we are doing is drawing a weighted curve through points of different values.

Q. Right. You weighted everything you can on your method of weighting, applied Boyle's law to it and didn't get a straight line; then you went to this least squares and you straightened out Mr. Boyle's line. Now, isn't that just what you did?

A. No, that is not a true statement of it at all.

Q. Well, I wish you would state it absolutely as you did it.

A. We utilized the five years of weighted pressure decline and production and for each year of the five years that was calculated and the curve represents, not one year or not a point from one year to two years, but a weighted curve for all of the years. That's what your production per acre pound decline is based on, not one year.

Q. I understand very well, Mr. Hammer. Now, let's go back to 4B, to the curve which you have extended out there across your paper three times. Isn't that the curve that Boyle's law gave you as you applied it?

A. Yes, it is.
Q. Well, let's look at it.
A. All right.
Q. Here on Page 4B, if you drew a line from the center of your first point to the center of the second point, which you didn't do, it would drop down from the way you have it, isn't that right?
A. Yes, but it wouldn't mean anything.
Q. You just answer my question.
A. I said yes.
Q. Then you draw a straight line from the middle of that point to the middle of the next one and it would be slightly below where you have it there?
A. That is true.
Q. Then you draw a straight line from that point to the next point and it would end up slightly above where you have your line, wouldn't it?
A. That is also true.
Q. And if you draw from there to the next one it would be slightly below?
A. That is also true.
Q. That is the curve of the line you got from applying Boyle's law?
A. No.
Q. How did you get it?
A. The line we got from applying Boyle's law is the line upon which these larger points are projected.
Q. Where did you get the line as we have reconstrued it, drawing it from the center of one point to the next? Where did you get that line?
A. I didn't get any line drawing from the center of one point to the other.
Q. If you had plotted it accurately that is the point you would have gotten?
A. It is not, or any other method under Boyle's law, where you are weighting out several years.
Q. Look here, Mr. Hammer. You have a pressure drop It takes you down to this point here, starting here (indicating), and you draw a straight line across there and you have a pressure that takes you down like that and you plotted it in and it comes out like that and you plot it in and comes down like that and you plot it in. Can you see that line? (Indicating in Exhibit 179.)

A. I can see it approximately.

Q. That is precisely what you get when you take the data which you have and plot it on a curve, isn't it?

A. That is the curve you get when you plot your pressures against your accumulated production.

Q. All right, isn't that what you are doing here?

A. Yes, but all of the things you are talking about have been weighted in and in a determination—

Q. As you have described it heretofore, in getting your points to construct this irregular line you have indicated there?

A. I had all the data, yes, and utilized it.

Q. And you did all of your weighting then, too, didn't you?

A. When I arrived at the production per acre pound decline.

Q. That is right, you had all that, didn't you?

A. It is all weighted in.

Q. And you had that when you reconstructed this irregular line, didn't you?

A. (Pause).

Q. Will you answer my question?

A. I had all the data, naturally, from the beginning.

Q. It has been suggested that you might not understand my question.

If you are plotting it by year like the one we are talking about—the one we were talking about was in your Exhibit 180—

A. If you plotted your accumulated production against—

Mr. Spencer: By years—

The Witness: —your pressure decline.

By Mr. Keffer:

Q. That is right, year by year.

A. Or any period. It just happens that year to year was used.

Q. When you did that you had an irregular line instead of a straight line?

A. Certainly.

Q. Well, I guess we are talking about different things.

When you make that irregular line a straight line, how do you do that?

A. That is where we utilized this simultaneous equation as shown on Page 3.

Q. Sir?

A. That is where we utilized this simultaneous equation shown on Page 3, Exhibit 180.

Q. How many other fields have you used that simultaneous equation on, Mr. Hammer?

A. I haven't used it on any others.

Q. I see. Do you know any other field—strike that.

It is the first time you have ever tried it?

A. Well, it is the first time I have ever tried it for a particular case like this.

Q. And you haven't any experience to know whether it is going to pan out or not; you are going to have to wait until the field is exhausted before we can tell, is that right?

A. No. It has already been proven. The curve right here (indicating) proves it.

Q. You have a straight line. You will have to get a straight line when you apply that formula, no matter how crooked it was?

A. Yes, and it checks in with your accumulated production as against your pressure decline. What better proof do you want?

Q. How do you mean it checks?

A. It draws the best possible curve that you could get through those five divergent points.

Q. Do you have the charts on the other quadrants you made your basic line from?

A. It wasn't necessary to make one. I just made one by point of illustration. When you get your production per acre pound that is equivalent to a curve.

Q. Well, as I recall, when we got our production per acre pound on various quadrants every time we had a different grouping we got a different figure.

A. Well, when we grouped different acreages and the factors contained in those different acres, why, naturally we would get a different figure.

Q. But not from the particular quadrant? The gas didn't change in place under that quadrant, did it, just

because you made a different grouping of some other quadrant?

A. No.

Q. The gas didn't know you did that?

A. But the weighted pressure—I thought I explained that sufficiently. Just take your Quadrant 3 here—

Q. Sir?

A. The whole idea—I think it is sound—I think it is sensible and I think it is fair—is to take instead of one quadrant alone where there is indication of the movement of gas either to or from a five-year period—the quadrant upon which you want to make your determination in those adjacent quadrants, and from a group arrive at a production per acre pound.

Q. Yes, I know that.

A. It can then be applied to the quadrant in question.

Q. All right. Now, you have drawn a line on Quadrant 3, Potter County, and you have drawn a master line for all of the quadrants in which Canadian River acreage is located, based upon Quadrant 3, Potter County, is that right?

A. No.

Q. Why did you show Quadrant 3 in Potter County?

A. I have just finished explaining that every time you make a calculation for production per acre pound decline it is equivalent to drawing a curve.

Q. Suppose it wasn't per acre pound decline, just a decline of so many pounds per so many billion feet of production, what is the difference?

A. There is a lot of difference.

Q. Tell me the difference.

A. What?

Q. Tell me the difference.

A. Well, this whole thing is a weighted proposition. You have to weight it against your acreage and you have to weight it against your pressure decline and in doing that we had to construct these isobars in order to get the proper weighting. Now, those factors are all weighted in. You can't just grab a lump figure out of the air and utilize the same principle.

Q. When you get your acre pounds that is just a matter of weighting your basic segments, isn't it?

A. When you get your isobar segments?

Q. That is all you do?

A. That is right.

Q. And that is all there is to it?

A. As far as the acre pound is concerned.

Q. That is right, as far as the acre pound is concerned. If you took your isobar lines or segments all the way across the field as you have drawn them here and get a weighted average pressure for the fields, you would have the same thing, wouldn't you, expressed in a different manner?

A. Yes, that is the basis upon which I gave you those weighted pressures.

The witness stated that you could calculate production per acre pound for the entire field in the same manner that he calculated production per acre pound for each local area (quadrant), and that if one wanted a picture of what was actually happening in the field he could plot the weighted pressures as against production for each yearly period, and this would show what the field was doing with respect to decline in rock pressure as related to production.

He stated the picture would probably be accurate, but it wouldn't be practicable to apply the results to any local area in the field, but still it would be accurate in so far as the application of Boyle's Law to the field-wide picture is concerned.

The witness further testified (Vol. 58, pp. 8212-8213) as follows:

Q. I mean when you plot your pressure drops against production you don't have a straight line?

A. As I have said before, and I think your own men will agree with me, they have seen, literally speaking, probably hundreds of curves plotted, each on individual wells, and there is always variation, more or less. If they plotted the curves themselves they would try to plot that mainly so it would go through those points and give the best straight line.

Q. But when you are extending it, giving the best straight line, that is when you are using your own judgment?

A. No, you are not. You are projecting into that in the future as to the history it has shown in the past.

Q. Suppose you had used your last two points on plotting your straight line on Page 4B, it would have been slightly a different line, would it not?

A. Page 4B?

Q. Yes.

A. Yes, and if you had used your 1937 and 1938 you would have had another line.

Q. And if you had used the 1935 and 1936 you would have still had another one?

A. There is no argument on that.

Witness had left out Wheeler County Quadrant 1 in determining his weighted average pressures, and gave as his reason the following:

> "Certainly if I had reason to believe, or if any other engineer happened to believe that a certain area, although some railroad commission or somebody might have included it in an area, that that particular area was not productive and had no value, I think you would be wrong in including it. That is my position on it."

Witness stated that if Boyle's Law were working perfectly you could not take any year, or any other period, and get the same results because the data might vary from time to time but that if you had accurate information the results would check. For example, the estimate would be the same if the data for the period from 1935 to 1936 only were considered, or from 1938 to 1939, or any other yearly period, if the data was perfect and if you had absolutely ideal conditions. The witness means by an ideal condition —an experimental application of Boyle's Law, such as a laboratory experiment.

Again referring to the original of Wheeler County Quadrant 1 in his estimate of field reserves, the witness stated that he had not utilized it because there was no recorded production that the railroad commission had during the five-year period he considered. It was then called to his attention that his work sheet showed that during that period there had been produced from this quadrant 523,-042,000 cubic feet. Witness insisted, however, that even so, this was not much gas and still insisted that the quadrant was largely exhausted of its gas. He was then asked if his computations on the Wheeler County Quadrant 1 did not give an acre pound factor of 30.24, and he could not recall whether it did or not, but that the figure of 30.24

was reached by him by the application of the least squares theory and subject to check.

The witness further testified with respect to Wheeler County Quadrant 1 (Vol. 58, pp. 8233-8236) as follows:

A. But when we found out that the area looked like it was depleted as far as any oil or gas was concerned, and particularly as far as gas was concerned, there was no reason for utilizing and figuring the future reserves if there wasn't any gas left there. I mean, of course, you might drill a well and get a show of gas, or a small well, but for all practical purposes we considered it a depleted area.

Q. All right, but you got this 30.24 by the application of this least squares theory, didn't you, when you worked it out?

A. Yes.

Q. And that gave you an original acre content of better than 13 million feet per acre, didn't it?

A. I would have to check that. I don't recall that.

Q. And that is the reason you threw it out?

A. That is not true.

Q. You knew that answer you got was out of all proportion than from what the physical conditions showed as being there; you threw it out definitely because your system wouldn't work and you didn't want it to come out in this case?

A. That is not a true statement.

Q. Give a true statement.

A. I have already given it.

Q. All right. When you applied your pressure decline method in the least squares, Quadrant 1, Wheeler County, as you applied it to the field you got an acre content of 13 million cubic feet per acre; that is right?

A. I say it is right, subject to check.

Q. You knew there was a field that was depleted and you had five hundred million cubic feet in figures, a difference of 26 to 1, and you knew you couldn't come into this case with a discrepancy such as that?

A. Well, that statement that you are making is absolutely untrue.

Q. You did have that discrepancy?

A. I have stated that we found out that the area was depleted and we decided not to use it. I stand on that.

Q. All right, it did show 13 million feet per acre, as you computed it?

A. I don't recall.

Q. Will you check your working papers?

A. Yes, I will check them.

Q. You knew it didn't have anything like that, didn't you?

A. Well, I don't remember whether it was that or whether it was something else. I want to check that whole situation.

Q. You have stated many times it was worthless; therefore, you didn't include it?

A. I think you are in erorr as far as that 13 million cubic feet is concerned.

Q. You can check that to see if I am in error.

A. Yes, I will check it.

Q. Now, if you made some particular effort on the field-wide figures to have gone back to the beginning of production, you would have had a lot larger volume of gas to have considered and a lot larger producing history to have considered, wouldn't you, Mr. Hammer?

A. That is true, if it had been possible to get it.

Q. But even with some diligent work you could have gotten pretty accurate figures on that?

A. I doubt it very seriously.

Q. You didn't try?

A. I asked a lot of questions—

Q. But you really didn't get down and try to get the figures, did you?

A. When folks like Phillips Petroleum Company who have been in there from the beginning and who had probably more scouts in the field than anybody else and had made an effort to keep a record of all of the wasted gas and all of that sort of thing, will tell you that they are not sure of their estimates. I would like to know how anyone else could do it with any degree of accuracy.

Q. Can you ever be sure of an estimate?

A. You never can be sure on estimates of that type.

Q. You have made an estimate of the field here, haven't you?

A. Yes, on data and records.

Q. You are not sure of it?

A. Yes, I am relatively sure.

Q. I thought we agreed several times that no one could be certain about that.

A. Of course, there is never one thousand per cent accuracy. Your men don't have one thousand per cent accuracy.

Q. I will grant you that.

Since we can't be certain about any of these things, it is obvious we should be as certain as we can?

A. That is right.

The witness further testified (Vol. 58, pp. 8241-8246) as follows:

"Q. Mr. Hammer, just another question on your Wheeler County Quadrant 1. You gave us one of the reasons why you didn't use the production history, and you had a production from that quadrant of 523,000,000 cubic feet of gas. Now, I will ask you if you have other quadrants in the field in which you had less production even than that and which you did use.

A. I couldn't answer that from memory.

Q. Let me ask you this and you can check it: Didn't you have from Gray County 1, a production of 80,513,000 feet? Look at your papers and see if you didn't.

A. I don't have that statement for the whole field. I don't have it here.

Q. Don't your papers there show that? Don't you have that in your working papers? You don't have a single thing which you can check that with? It would be a most obvious figure. You ought to have something there, because that is the thing you had to have as the very basis of your calculations. Did you look in your suitcase—your briefcase to see if you don't have that? Do you have your working papers?

A. I have looked and I don't have my working papers here in the hearing room, not on the total field. I assumed that you were through with those. I didn't want to load this thing down and I took some of this out.

Q. Well, will you check that and see if that isn't a correct statement, and in Gray County, Quadrant 2, you had production up to August 1, 1939 of 240,300 cubic feet—Mcf. That's 240,300,000 cubic feet.

A. What were those?

Q. The previous one was 80,513,000 cubic feet, not Mcf.

A. What quadrant was it you wanted checked?

Q. Quadrants 1 and 2, Gray County.

A. Quadrants 1 and 2, Gray County, and what else?

Q. Well, let me check that—yes, that's what it shows.

A. Just those two quadrants, 1 and 2—1 and 5, Gray?

Q. That's right—well, you got those for 1 and 2, haven't you, Gray County?

A. Yes.

Q. And your figures to verify?

A. 1 and 2, yes, that's right.

Q. That's right.

A. Those are the two you want?

Q. That's right. You might verify the figure we gave you on Wheeler County which is taken from your working papers. That's Wheeler County 1.

The Trial Examiner: What was that figure, Mr. Keffer?

Mr. Keffer: That figure was 523,042,000 cubic feet.

The Witness: All right, I'll check that one.

By Mr. Keffer:

Q. Now, Mr. Hammer, I asked you the other day if your figuring this field by quadrants didn't give you a bigger figure—a bigger reserve than you would have gotten if you had figured the field as a whole and you said you didn't know.

A. No, I don't think I said I didn't know. I said my remembrance—my remembrance is that I said that I thought that the calculation of the field by the quadrant system would give me a more accurate result than if I tried to do it by the whole area.

Q. I know, but the question I asked you was if it didn't give you a higher result and that is what you weren't certain about.

The Trial Examiner: Mr. Keffer, when that came up yesterday, wasn't it decided to let Mr. Hammer see if he couldn't find that figure in his working papers?

Mr. Keffer: I believe it was. Mr. Hammer hasn't given us a figure, however, the other figures which he has given us this morning I think will demonstrate that figure.

The Trial Examiner: I believe you brought that up yesterday.

Mr. Keffer: That's right, either yesterday or the day before.

The Witness: It was my understanding that I have given you all that you asked for. If I overlooked something, it wasn't intentional.

Mr. Keffer: I think we have it with what you have given us. I think the figure will work out.

Q. Now, you gave your weighted pressures this morning at the various years. Those figures were 369.25 pounds for August 1, 1935.

A. That's right.

Q. That is correct; then at August 1, 1936 it was 360.74 pounds.

A. That is correct.

Q. At August 1, 1937, 352.02 pounds.

A. 352.02.

Q. August 1, 1938, 343.01 pounds.

A. Right.

Q. August 1, 1939, 332.98 pounds.

A. That's right.

Q. All right, now, if—relating that back to your production figures for each year, Mr. Hammer, you had the period 1935 to 1936, 620,404,940 Mcf., did you not?

A. No—you mean from August 1935 to August 1936?

Q. Yes.

A. Well, the figure there is 615,778,940.

Q. Oh, yes, I see the difference. If you included Wheeler County 1, you would have had 620,404,940. You would have five million more there.

A. I hadn't made the addition. I assume if you added that five that it would give you something like that.

Q. But the figure you did give was 615,778,940 Mcf.

A. That's right.

Q. And you had a pressure decline that year, that is, from 1935 to 1936, on your pressures as you have figured them of 9.24 pounds.

A. No, it is 8.51 pounds.

Q. All right. I have the figures with the Wheeler County quadrant in. That's where we are off. I thought the adjustment had been made here, but it has not. Just one second and we'll take those figures with the Wheeler County quadrant out.

Mr. Keffer: I believe, Mr. Examiner—I thought we were in position to go into the matter, that the matter had been computed and the figures worked out, but with Wheeler County quadrant left out, but those figures are in. In the figures that were presented this morning the Wheeler County quadrant was left out and it has thrown our figures a little bit haywire and it is going to take a little time to figure the matter and that being true, and, further, the fact that the large sheet that was handed Mr. Hammer yesterday for verification has not yet been verified.

Mr. March: We'll stipulate that it is correct.

Mr. Keffer: How's that?

Mr. March: We'll stipulate for the record that that is correct.

Mr. Keffer: That sheet is?

Mr. March: Yes.

Mr. Keffer: All right, that's fine.

Mr. March: We haven't checked it, but we will stipulate that it is correct.

Mr. Keffer: That's right, we do get back to the Wheeler County matter again.

Witness Hammer further testified on cross examination, Vol. 59, pp. 8298-8466, inclusive, and particularly pp. 8309-8359, as follows:

Q. Mr. Hammer, I asked you yesterday for another computation for the production figures on Gray County, Quadrants 1 and 2. You said that you couldn't give me that at that time but that you would get it. I wonder if you would do that now?

A. I have the production figures here for Gray—let me explain this. I have them separated all right, but in utilizing—

Q. Just answer my question.

Mr. March: He is going to answer it.

The Witness: I want to make an explanation.

Mr. March: He is going to give you the production figures.

The Witness: While I set out two quadrants—I call them Quadrant 2 and Quadrant 5 in Gray County, because of the size and the position of it I utilized Gray County 5 and Gray County 2 together. I have separate figures for Quadrant 2 and Quadrant 5 but in the compilation I threw it in all as one quadrant because of its position.

By Mr. Keffer:

Q. All right, give me the figures on Quadrant 2 and Quadrant 5, Gray County.
A. The year ending August 1, 1935, zero production—

The Trial Examiner: From which—

The Witness: This is Quadrant 2, Gray County, 1936.

By Mr. Keffer:

Q. Just give the total figure.
A. For the four-year period?
Q. Yes.
A. For the four-year period, 865,360 Mcf.
Q. Now, just a minute. What quadrant was that?
A. Quadrant 2, Gray.
Q. All right, give me by years, then—let's see how you get that figure.
A. 1936, 144,465 Mcf.; 1937, 1938 and 1939—
Q. No, give it just for 1937.
A. Well, I'm going to give them to you. For some reason that I don't remember, we got a figure from the Commission records of a total of the last three years and we simply divided that equally for the three years of 24,300 Mcf. In other words, the tabulation would be 243 hundred; 243 hundred; and 243 hundred for each year consecutively for 1937, 1938 and 1939. I don't recall exactly where—how we happened to get that lump figure.
Q. Sir?
A. I don't recall how we happened to get that lump figure and divided between the three years.
Q. Could we have your working papers just a moment on that, Mr. Hammer? You don't want to change your answer on that?
A. Let me see those working papers a moment.

Mr. Spencer: Mr. Examiner, while they are looking at their working papers, may we have an exception to the Examiner's ruling a few moments ago?

The Trial Examiner: Yes.

By Mr. Keffer:

Q. Do you have them?

A. That's right.

Q. Now looking at your work sheet covering Quadrant 5 and 2, Gray County, what is the total figure that you have at the bottom?

A. That total figure that you would have at the bottom there isn't representative of 2 and 5 alone.

Q. Oh, what does that represent?

A. Well, you see in here is 2, 4, 5 and 6.

Q. All right.

A. I just picked off there—

Q. Let's take Gray County 4, for the purpose of illustration. What was the production from it for four years? Where are your years on that? I can't see it. What was the production in Gray County 4, 1936?

A. 14,718,527 Mcf.

Q. All right, what was the production in 1937?

A. Four?

Q. Yes; the same one.

A. 30,026,866.

Q. All right, what was the production in 1938?

A. 45,181,050.

Q. All right, what was the production in 1939?

A. 58,446,879.

Q. All right, now will you turn to your work sheets and show me what you show as the total production from Gray County 4 during those years?

A. That seems to be the only tabulation in these working papers that gives it.

Q. That gives it?

A. Yes.

Q. All right, where is it? Give me the figure.

A. Well, it would be the summation of these that I have just read.

Q. All right, just read your summation on it.

A. I would have to add it up.

Q. Haven't you got it already summed?

A. No, not individually.

Q. Let's go back, then, to that original sheet we were looking at on Gray County 2 and 5.

A. Well, this sheet right here.

Q. All right. You show me the accumulated production on Gray County 4 and you show it on the sheet you are now examining.

A. Again, that is the group accumulated there.

Q. I know, but you have it for each quadrant in the group, don't you?

A. Yes, but again I would have to pick it out and make an addition.

Q. Well, let's look down here. What is the figure—Gray County 4? Just read the figure there.

A. Wait a minute, I want to do a little checking here.

The figures that have already been read into the record are the correct figures for the four years.

Q. How do you mean, correct figures for the four years?

A. Well, I mean I have checked them. Those are the production by year.

Q. All right.

A. Now, to get the total I would have to add those together.

Q. All right. Turn to your Hartley County quadrant.

A. No, I'm going to finish this. Why hop to Hartley? Do you want this figure?

Q. All right, go ahead. I was just trying to help you a little and save a little time.

The Trial Examiner: Do you want the record to show that?

Mr. Keffer: It is already in the record. It doesn't make any difference.

The Witness: The figures are in the record.

The Trial Examiner: Very well. Go ahead, Mr. Keffer.

By Mr. Keffer:

Q. Well, let's turn to the Hartley County quadrant, Mr.

Hammer. Give me your annual production figures on that one.

A. All right, the 1936 figure, 793,677 Mcf.; 1937, 3,322,690 Mcf.; 1938, 5,112,209 Mcf.; 1939, 6,785,156 Mcf.

Q. All right, now, will you total those and tell me what the total production has been from that quadrant during that period?

A. The total figure there, unless I have made a mistake in addition, is 16,013,732 Mcf.

Q. That's right.

A. Or 16 billion—

Q. 16 billion plus as the total production from the quadrant for those four years.

A. That's correct.

Q. Now, again, you are trying to run into the word "approximately" there. That is the figure unless you have made some slight error in addition?

A. All right.

Q. Mr. Hammer, is that true of all your quadrants? Have you figured them that way in getting the total production in order to get your acre pound?

A. Yes, we got the total production by years.

Q. And then added them all up?

A. And then took the summation of the totals.

Q. And it is upon that basis that you determined your acre pounds, is that correct? by relating your pressure decline to your production figures?

A. Yes, annually; that is, taking it five years through.

Q. Well, now, those figures that you have there, as you have computed it there, if they are erroneous, then your acre pound figure would be entirely out of line, wouldn't it?

A. Those are the figures we got from the Texas Railroad Commission. If the Railroad Commission didn't have them correct, why—

Q. But even so, if you made an erroneous calculation there, then your acre pound answer would be an erroneous answer, wouldn't it?

A. Will you read that question, please?

(The question referred to was read by the reporter, as set forth above.)

The Witness: If you made an error, yes.

By Mr. Keffer:

Q. That's right, and in the approach you make of this field—the pressure decline approach is primarily a mathematical approach, isn't it?

A. It is an approach from the standpoint of mathematics and physics, that's right. It is a mathematical calculation.

Q. It has nothing to do with geology as such—it is a mathematical problem?

A. That's right.

Q. Now, Mr. Hammer, you feel that you did that correctly, of course, because in applying your formula if you didn't do it, why, your whole figure on a quadrant or on a field would be an erroneous figure, would it not?

A. If the formula were in error and was not applicable, of course, that is true.

Q. You would get an erroneous figure, but even if the formula were correct and you made an improper application with the figures you had you would still get an erroneous figure, would you not?

A. That is true. I don't think I did, but if I did I would have.

Q. I appreciate that, but in making a study of the character you have, you have to be very careful to be sure that you don't make a mistake in arithmetic?

A. Yes, where you have used as many figures as we have.

Q. Now, Mr. Hammer, what would you say if I told you you had made a very *grevious* mistake in the calculations you made there?

A. You would have to prove it to me.

Q. Would you be hard to convince?

A. I don't know as to that.

Q. All right, now, I am going to prove it to you. Now, I take it if I prove it to you on this you will agree with me that you might have made a lot of other mistakes and your figures would be all haywire, wouldn't they?

Mr. March: I object to that—

Mr. Keffer: I'll withdraw it.

The Trial Examiner: He withdrew it, Mr. March.

By Mr. Keffer:

Q. Now, Mr. Hammer, will you look at your Exhibit 180, Table 1, Page 5, and tell me what you show as the total production from the Hartley County quadrant?

A. 5, you say?

Q. Yes. The page is on the back. It is the tabulation you have there just following your statement—wait a minute. It's 2. Read the figure you see there set out already.

The Trial Examiner: What was that, Mr. Keffer? Hartley?

Mr. Keffer: Hartley quadrant. That is the one right at the top of the page.

The Trial Examiner: Yes, I see.

Mr. Keffer: The total production since August 1935 as shown on that schedule.

The Trial Examiner: Do you want him to read that into the record, Mr. Keffer, for the five years?

Mr. Keffer: That's right.

Q. Just read it in.

A. All right, I want to do some checking about the other figures I put in.

The Trial Examiner: Follow Mr. Keffer and then if you wish to expand on it or explain it, Mr. Hammer, you will be given an opportunity to do so.

The Witness: All right, though I want to explain it the minute I get through.

The Trial Examiner: That's all right, but follow Mr. Keffer.

The Witness: The figures on Table 1, Page 2 of Exhibit 180, 793,677—

By Mr. Keffer:

Q. I want you to give me, Mr. Hammer, if you have it there—

A. That's what I am doing.

Q. —the total production from the Hartley County quadrants covering the periods which you testified about a while ago.

A. Do you want that added up again?
Q. No.
A. Well, it has to be.
Q. What do you say at the top of that column?
A. I say, "Accumulated Production."
Q. What does that mean?
A. All right—
Q. All right, go ahead, then, and do it your own way.
A. All right, this is accumulated production.
Q. All right.
A. 793,677 for 1936.
Q. Now, let's go slow.
A. —and 3,322,690 for 1937; 5,112,209 for 1938; 6,785,156 for 1939.
Q. Those are Mcf. figures?
A. Yes, those are all Mcf.
Q. Now, do you want to add them?
A. No. The figures that I previously read into the record as being annual production figures were in reality accumulative production figures. In other words, I didn't notice "accumulated production" at the top of the column of the work sheet when I read them in, the figures that I gave

The Trial Examiner: Let's see, that was the figure for Hartley County, previously?

The Witness: That's right.

Now, in Table 1, Page 2 of Exhibit 180, the figure given there for 1936 is 793,677.

Mr. Lange: That is Column G?

The Witness: That's right.

All right, come down to 1937 and the figure on the tabulation just mentioned is 3,322,690. It is the same figure on the work sheet that was read into the record. Take 1938, the figure on Table 1 is 5,112,209. It is the same figure that is on the work sheet. Take 1939, Table 1 shows 6,785,156 Mcf., and it is exactly the same figures as shown on the work sheets; so the figures check.

By Mr. Keffer:

Q. All right, you do want to correct your statement, I take it?

A. As to those originals being yearly figures?

Q. That is right. I asked you right at the start if they weren't accumulative figures and you were very positive they were not.

A. That is correct.

Q. So an eminent scientist in mathematics where he has a mathematical problem may make a mistake?

A. I suppose that is true. It has been done.

Q. And even a rather simple problem?

A. Yes, that is true. It can be done.

Q. Now let's get back to Gray County and let's give the correct figures on Gray County quadrant which I was asking you about a while ago. You made the same mistake in Gray County that you made in Hartley County, didn't you?

A. I don't know.

Q. Check it and see.

A. Mr. Keffer, which quadrant were you referring to in Gray County?

Q. Quadrant 1 and Quadrant 2, the ones we were talking about.

The Trial Examiner: Is that Gray County, Mr. Keffer?

Mr. Keffer: I am sure that is what it is. It is Gray County, Quadrant 1 and Quadrant 2. If I made a mistake in stating it I want to correct that.

The Witness: I didn't know what I was checking.

By Mr. Keffer:

Q. I want them separately, Mr. Hammer.

A. Well, Gray County 1 is the small quadrant—the quadrant that has the small area inside the boundary.

Q. Well, here, isn't this the top boundary line I draw my pencil across?

Mr. Spencer: Across where?

Mr. Keffer: I can't read the map. I can't read the figures here on the map.

Mr. Lange: It is Quadrant 6, Gray County.

By Mr. Keffer:

Q. Just give me the acreage. That is a better way than any to determine the size.

A. If I have the acreage here I will give it to you. I don't know whether I have it available or not.

Q. Go ahead. We can look up the acreage later.

A. All right. That area down there didn't start to produce gas until 1939.

Q. All right, then, you had zero 1936, zero 1937, zero in 1938, is that right?

A. Yes, and it started to produce in 1939.

Q. All right, what did you have in 1939?

A. 80,513 Mcf. in that year.

Q. All right, give Quadrant 2.

A. The only figure I seem to have here is the accumulative figure.

Q. All right, read the accumulative figures year by year. You can determine by subtraction then what the production has been each year, can't you?

A. It could be done.

Q. Read the accumulative figure. Just read them. You have them there in front of you.

The Trial Examiner: Can you find the figures, Mr. Hammer?

The Witness: I can find the figures, but you see the thing that makes it difficult is that two of them have been combined.

Mr. Keffer: You had them all set out separately when we were looking at them on your work sheets.

The Witness: Yes, but what I am trying to do is to check back as to whether they are actually accumulative or are actual production.

Mr. Keffer: You can read the figures readily. I thought we decided what they were.

The Witness: Well, I want to do a little checking.

The Trial Examiner: We will stand in recess for five minutes.

(At this point a short recess was taken, after which the proceedings were resumed as follows:)

The Trial Examiner: The hearing will be in order.

By Mr. Keffer:

Q. All right, Mr. Hammer, will you read the yearly accumulative production figures on Quadrant 2, Gray County?

A. Yes.

Q. All right.

A. In 1936 it was 144,465 Mcf. Apparently—well, it is certain in 1937 some time there was a production of 95,385. The two added together would give you the total accumulated in the amount of 240,300 Mcf.

Q. That was accumulative production in what year?

A. Well, that came in in 1937.

Q. All right, give your figures for 1938.

A. No, I want to make this statement—

Q. Give the figures and then make the statement.

A. For 1938?

Q. Yes.

A. Well, of course, that was an accumulative figure taken through to get it.

Q. Just read it.

A. 240,300.

Q. That is what I wanted. Now read the 1939 figure.

A. 240,300.

Q. All right, that is what I wanted. Now go ahead and make your explanation.

A. All this discussion of this production in Quadrant 2 or in any other quadrant in arriving at, for the record here, the production figures, has made no difference and has made no error whatsoever in the calculations to arrive at the production per acre pound to be applied. It is simply an error in reading from the wrong column in the work sheets.

Mr. March: The figures in the exhibit are correct?

The Witness: That is right.

By Mr. Keffer:

Q. You told me a while ago there wasn't any error in the figures you were reading of annual production, didn't you?

A. Well, I have corrected that.

Q. ~~Yes, that is~~ right. And if you made a mistake in this other you reserve the right to correct it, too?

A. You mean in the calculation?

Q. Yes.

A. They were checked so many times I don't believe there were any errors.

Q. These were checked, too, weren't they?

A. Well, they were checked here *hurridly* on the witness-stand, yes. There is quite a difference between that and checking a bunch of figures yourself and having three or four other fellows check them over a period of three or four months.

Q. Did you yourself compile those figures and write them into your work sheets, Mr. Hammer?

A. Not all of them, no; very few of them, as a matter of fact, as far as the work sheets are concerned.

Q. Who prepared those figures?

A. Well, I had—I can't recall. I think principally as far as the compilation of these figures was concerned, it was done by two different men.

Q. Who were they?

A. A fellow by the name of Jack Daugherty and *Charels* Pettingall. I do remember very distinctly that in all cases they checked back against each other. In other words, I required if one figured out a bunch of calculations that the other would take those and then check them and they were checked and rechecked back and forth that way.

Q. They prepared your working papers, then, on your accumulative production figures and annual production figures, is that correct?

A. That is right.

Q. You had nothing to do with it?

A. Except that they would come to me and we would go over it. If there was an error I would say, "You check this and see that you are right. You check this and see that you are right."

Q. What part did Mr. O'Connor and Mr. Stevens have to do with the preparation of that?

A. The work sheets?

Q. Yes.

A. None whatever.

Q. How's that?

A. None whatsoever.

Q. I noticed Mr. O'Connor and Mr. Stevens were in conference with you to help you straighten out the mistake you

made during the recess. If they had nothing to do with the preparation of the papers, how did they know anything about it?

Mr. March: I object to that question. That presumes that Mr. O'Connor and Mr. Stevens did straighten him out on something. That hasn't been proven. Why don't you ask him whether he did?

Mr. Keffer: I will ask that very question.

Mr. March: You ask that very question.

By Mr. Keffer:

Q. Did Mr. O'Connor and Mr. Stevens assist you in properly interpreting your working papers?
A. Properly interpreting—
Q. Yes.
A. I wouldn't use the word "interpreting."
Q. What would you use?
A. They called my attention to certain things.
Q. I see.
A. That put me straight. Your men would do the same with you.
Q. Surely. Hadn't I already called your attention to the very thing?
A. Yes, I think you had.
Q. Then you already knew it, didn't you?
A. I didn't understand you.
Q. Oh, I see. All right, I am sorry, Mr. Hammer, if you didn't understand me.

Mr. March: As a matter of fact—

Mr. Keffer: What's that?

Mr. March: Do you want to know? If you want to go as far—

The Trial Examiner: I don't believe at this point the record reflects accurately just what figures you referred to as having been read into the record that were erroneous, Mr. Hammer.

The Witness: I will give you my remembrance and if I am not right, Mr. Keffer can check me.

Mr. Keffer: All right.

The Witness: I think it referred to arriving at the right accumulative production figures for Hartley County and arriving at the correct accumulative production figures for Gray Quadrant 2, and Gray Quadrant 1.

Mr. Spencer: I think there were also some figures in there with respect to Quadrant 4 that Mr. Keffer asked you about. I think that is what the Examiner has in mind. You did give some figures on Quadrant 4, Gray County, and I think the same thing would apply to those.

Mr. Keffer: Quadrant 4, Gray County, was where I was checking you on another work sheet, Mr. Hammer.

The Witness: That is correct.

Mr. Spencer: With the inclusion of that one, I think you have named them all.

The Witness. Those were the figures that we read off—well, those figures that were read off on Gray Quadrant 4 were also accumulative figures.

By Mr. Keffer:

Q. The answer you gave originally was erroneous as to those?

A. That is right.

Q. Getting back to Wheeler County, Quadrant 1—

Mr. March: Before we go further I want to make this observation: It has been intimated that Mr. Hammer has made some improper use of his associates—

Mr. Keffer: I made no such intimation and if it is so considered I will apologize to Mr. Hammer and everyone else. Is that sufficient?

Mr. March: When Mr. Rhodes was on the witness-stand he frequently conferred with his associates and we made no objection.

Mr. Keffer: I made not the slightest character of a suggestion—

The Trial Examiner: I recall very pointedly you made it on the record, Mr. March.

Mr. March: I might have done that but I never intimated Mr. Rhodes didn't prepare his own exhibit.

The Trial Examiner: I don't think Mr. Keffer intended to make any such intimation.

Mr. Keffer: I certainly did not.

Mr. March: That is satisfactory, then.

Mr. Keffer: I am simply trying to find the facts and that is all.

Q. Now, Mr. Hammer, when you excluded Quadrant 1 in Wheeler County, did you have much higher production in that quadrant than you had in Quadrants 1 and 2, Gray County, combined?

A. What is that accumulated figure for Quadrant 2, Gray County?

Q. Quadrant 2 has the figure of 240,300. I am quoting it from memory. Quadrant 1 was 80,513.

A. Yes, over a total period—

Q. A total period for the two quadrants, Quadrants 1 and 2, Gray County, amounting to something more than 320,000 Mcf., slightly more than that, is that correct?

A. 320,813.

Q. What was the production in the same period in Quadrant 1, Wheeler County? Give it by years.

A. This is for 1936, 79,105 Mcf.; 1937, 212,266 Mcf.; 1938, 316,324 Mcf.; 1939, 523,042 Mcf.; a total of 1,130,737 Mcf.

Q. Well, then, you had a lot more production from Quadrant 1 in Wheeler County than you had from Quadrant 1 and 2 in Gray County, didn't you?

A. That is right.

Q. As a matter of fact, Mr. Hammer, I am going to help you. Haven't you made the very mistake on Quadrant 1, Wheeler County, that we have been talking about on all these others, mistakes favorable to me? I am going to give you a chance to correct them so that the record may properly reflect the actual figures.

A. Will you read that question—not the statement but his question, if he had one?

(The record referred to was read by the reporter, as set forth above.)

The Witness: I don't understand that statement "favorable to me."

By Mr. Keffer:

Q. All right. If you had a great big production in Wheeler County, wouldn't that be one more reason to consider it in Wheeler County Quadrant 1?

A. You can't answer that categorically for the reason that here is a case where we are taking Quadrant 1 and Quadrant 2 in Gray County where new wells have been drilled and production has started to come out. For instance, we don't know yet what Quadrant 1 in Gray County would have produced over the same period of years to compare with this.

Q. I know that. Now let's get back—

A. You can't make a categorical answer because—

Q. I appreciate you can't, but if you had a quadrant in Wheeler County that was producing substantial volumes of gas today and had produced over a trillion feet of gas—

A. A what?

Q. A trillion feet of gas.

A. Oh, no, not a trillion feet.

Q. What was that figure you gave, the final total figure?

A. That is a billion cubic feet of gas.

Q. That is right, a billion feet of gas.

Still you couldn't have given a very good reason for leaving it out, could you?

A. Well, I think so. Let me analyze that a little bit.

Q. All right.

A. Here is a four-year period of production. Over that four-year period of production in that area there was only 282,678 Mcf. produced annually. That is the average. You take that 282,678 and divide it by 365, the average production that came out of that quadrant over a four-year period was only 774,000 cubic feet a day.

Q. What was it in Quadrant 2, Gray County, per day over the four-year period? It was a whole lot less, wasn't it?

A. But Gray 2 and Gray 1, particularly Gray 1, are new developments. You haven't any method of comparison. You haven't any method of comparison. You have no way to compare it.

Q. All right. You just had one year's production on Gray 1, didn't you?

A. I don't know whether it started in January or December.

Q. But you just had one year's production?

A. All right.

Q. Is that right?

A. That is right.

Q. And in Gray County 2 for the last three years you didn't have a foot of production, did you?

A. All right.

Q. You didn't, did you?

A. No.

Q. Yet in Wheeler County 1 you had production every year during that period, didn't you?

A. That is right.

Q. All right, and you had more production, not only did you have it every year, but you had more production from Wheeler County 1 than you had from Gray County 1 and 2 combined?

A. There is no argument about it.

Q. All right, I guess that answers the whole thing as I view it, at least, Mr. Hammer. Is that about correct?

A. As you view it, I think that is correct.

Q. Now, Mr. Hammer, if as a matter of fact we hadn't caught the error a while ago which you did mak and which you later corrected, it would have shown a much better picture for Gray Quadrants 1 and 2, wouldn't it?

A. What do you mean, it would have shown a better picture?

Q. It would have shown a continuous production every year and a substantial increase in the rate of production, and it would have shown substantially more production for the period, wouldn't it?

A. You mean if they had produced all the way through? Is that the intent of your question?

Q. If they had produced that as you originally said they did before you discovered your error?

The Trial Examiner: You mean had they produced those amounts each year?

Mr. Keffer: That is right, which he originally stated.

The Witness: Yes, that correctly stated that—

By Mr. Keffer:

Q. I say, you would have had a much better picture if you hadn't discovered your error?

A. No.

Q. Why wouldn't you?

A. In the method we employed that error wasn't made.

Q. Mr. Hammer, I am talking about one thing and you are talking about another. You said yesterday that you left Wheeler County quadrant out because it wasn't worth anything any more; it was depleted; there was no production in it, isn't that right?

A. I said it was my remembrance that it was—that there were a lot of dry holes in there.

Q. And there is no production now, is that right?

A. Did I make such a statement?

Q. I think you did. I think that is the very reason you gave for leaving it out.

A. The intent was that—I believe I put it that way—

Q. I think you did.

A —that there wasn't enough in there to warrant the assumption that it would amount to very much as a gas producing area.

Q. Notwithstanding the fact it had produced substantial volumes of gas and was previously producing substantial volumes of gas?

A. Well, I left it out and I stated my reasons for leaving it out.

Q. That is right.

A. All right. What more is there to say about it?

Q. Nothing, except when we come over to Gray County Quadrant 2 we have much less production and we have a period of three years where it hadn't produced a foot of gas, yet you kept that one in for the same reason, I take it?

A. No, no, no. I utilized that with Quadrant 5 and called it one quadrant in my calculation.

Q. But you utilized it?

A. Yes, I utilized it.

Q. You could have utilized Quadrant 1, Wheeler County, the same?

A. Yes, I could.

Q. Surely. When we come to Quadrant 1, Gray County, that had only 80,000 cubic feet of gas and one year's history behind it, you used that one, didn't you?

A. Yes.

Q. If the reason you gave for excluding Wheeler County, Quadrant 1, is a good reason, then you also for the same reason should have excluded Quadrants 1 and 2, Gray County.

A. That is a matter of judgment.

Q. That is right. We will let it stand that way. That is my judgment of it, nevertheless. You grant me that right, don't you?

A. You can have that judgment if you want to.

Q. All right. Now, Mr. Hammer, let's go back for just a moment. You have given us, I believe, the average weighted pressures for the field year by year as taken from your working papers, is that correct?

A. Excluding—I don't recall—no, those included Wheeler Quadrant 1, I believe.

Q. No, they did not include Wheeler Quadrant 1, the figures that you gave us for the year.

A. That is right. The first figures I gave you—

Q. Sir?

A. The first figures I gave you didn't include—

Q. Did not include Wheeler Quadrant 1, that is right.

There seems to be some confusion. Do you have the same figures for the field including Wheeler Quadrant 1?

A. Had you asked me for them?

Q. I thought I had.

Mr. Spencer: I asked you last evening for them.

The Witness: Didn't I give them to you, Mr. Keffer?

Mr. Keffer: No, you didn't. You gave me the 1935 figures but no more than that.

Mr. March: He didn't use Wheeler Quadrant 1, of course, in this exhibit.

The Trial Examiner: He was talking this morning—

Mr. March: If he has it, I don't object to him letting him have it, but if he doesn't have it, I object to his having to calculate it.

Mr. Spencer: No one has asked him to calculate it, Mr. March.

The Witness: That isn't necessary. I am quite sure that in my notes some place in the last year or two I have seen those for the entire field, including—didn't I supply you a figure last night?

Mr. Keffer: You gave me the figure for 1935 but said you would be unable to include any more, which included Wheeler Quadrant 1.

Mr. March: I think he explained all that. When we found he was going to use it, I think he explained that several times.

The Witness: I think that is true. I coudn't find the figure last night for the entire field, taking in Quadrant 1, Wheeler County—I couldn't find anything except 1935 weighted pressure.

Mr. Spencer: What did you have reference to a moment ago, Mr. Hammer, when you said within the last two or three days you had seen or had those figures available in your notes?

The Witness: What I started to say, Mr. Spencer, was, there has been some misunderstanding on my part in exactly what Mr. Keffer wants. It might be—I don't know, but in going over my papers last night I could only find the one. If I had been able to find the other I would have been glad to have given them to him.

Mr. Keffer: All right. I have one more question before we leave that.

Q. The fact that you left Wheeler County, Quadrant 1, out of your calculations for the field necessarily changed your estimate of the field, didn't it, Mr. Hammer?

A. Yes, it did.

Q. Very much?

A. Oh, for the entire field, in round figures, it made a difference of 720 billion cubic feet.

Q. 720 billion cubic feet?

A. Yes; out of the total ultimate field reserves which is very small in the—roughly about two and three-quarters per cent, or something like that.

Q. That 720 billion is as much gas as the Canadian River Gas Company produces in how many years? Is it about fifteen years? Wouldn't it be about fifteen years on a 14.65 basis?

A. That is true.

Q. That isn't such an insignificant volume, after all, is it?

A. But from my viewpoint, Mr. Keffer—you have expressed your viewpoint; may I express mine?

Q. Yes, however, I have just one more observation on that.

During the entire producing history of the Canadian River Gas Company and its predecessor companies that have been referred to, all of them combined haven't produced half that much gas up to this day, have they?

A. Well, up to August 1, 1939, I think your statement would hold. I wouldn't want to stretch it up until the present time.

Q. They have produced more than 300 billion—less than 400 billion, in their whole producing history. I have forgotten the exact figures used in these different pressure bases, but on a 16.4 basis during that period it was 328 billion, or something like that. Is that your recollection?

A. Up to August 1, 1935?

Q. August 1, 1939.

Mr. March: Are you using Mcf. or cubic feet, Mr. Keffer?

Mr. Keffer: Mcf. However—it would be 328 billion cubic feet.

The Witness: I think I have the figure in my notes. I don't know whether I have it here or not but I will agree.

By Mr. Keffer:

Q. Have you figured it? I see Mr. O'Connor has been shaking his head.

Mr. March: Mr. O'Connor didn't have anything to do with this exhibit.

Mr. Keffer: I thought Mr. O'Connor did, the way he was grinning.

Mr. March: He doesn't know what the figures are.

Mr. Keffer: That is all right. The record will speak for itself. It isn't so important except for comparative purposes.

Q. Will you give me again the difference it made in your field estimate of—it was 700 and how many billion?
A. 720 billion.
Q. 720 billion?
A. That is right.
Q. I want to write it down here.

The Trial Examiner: Cubic feet?

The Witness: Cubic feet.

By Mr. Keffer:

Q. 720 billion cubic feet?
A. Yes, sir.
Q. Did that increase your estimate for the field 720 billion up or 720 billion down?
A. It was 720-billion lower.
Q. Lower?
A. Yes.
Q. You got a lower figure than you otherwise would have gotten if you had included it?
A. That is true.
Q. Well, how did you arrive at that figure?
A. What figure?
Q. This figure that made a difference of 720 billion cubic feet.
A. Since this question has come up I have gone back and made a calculation—that is, utilizing the field as a whole by this method of calculation, not by the summation, but by taking the field as a whole, using Wheeler County. That is how I arrived at it.
Q. That is about the only way you could do it, isn't it?
A. Certainly.
Q. I was certain of that but I wanted to know what tools you used in making that calculation.
A. What tools?
Q. Yes.
A. You have your calculation there.
Q. What rock pressures and what production figures did you use?

A. Well, I used the same tools as I have used for the entire thing.

Q. I know. If you will just go through, briefly, your calculation and give me the rock pressures you used and the production figures you used, that is all there will be to it, Mr. Hammer.

A. I simply made a tabulation here and gave the comparative figures.

Q. I know—

A. I didn't attempt to—

Q. I know, but when you figure the field with Wheeler County, Quadrant 1 in it you had to have certain rock pressures and certain production figures, didn't you?

A. Yes.

Q. I want to know what the rock pressures were and what the production figures were. That is all I am asking you for.

A. Well, as I said, I don't have them here.

Q. Can you get those for me, Mr. Hammer?

A. I'll try to get them for you, yes.

Q. Well, you just worked it out last night.

A. No, I didn't say I worked it out last night.

Q. I thought you did. I thought you said since this came up. This came up yesterday.

A. No, I said since I came up.

Q. Came up where?

A. Up to this country. That's been about four months ago.

Q. Then you do have the figures in Denver?

A. Well, I did have them, but I say, I can't find them. That's what is worrying me. I don't know where they are.

Q. What was the idea of working this out since you came up rather than before this came up?

A. If you will recall, Mr. Keffer, when this question of total field reserve came up I utilized an expression that I believe some of your legal staff did not like, an expression that used the word—

Mr. Spencer: Do you want me to tell you?

The Witness: Yes.

Mr. Spencer: Academic?

The Witness: Yes, that's it academic. One of the reasons why I used that word "academic" was—and I am still of the same opinion that as far as utilization of anything way over in Wheeler County in connection with Canadian River problems is an academic problem and that was my meaning in that case.

By Mr. Keffer:

Q. Well, all right—

A. It had been an academic problem ever since almost I started to work with the problem, that anything way in the eastern end of the field in my opinion—or, rather, in our opinion, hadn't any bearing on the Canadian River situation and it was, therefore, an academic figure.

Q. Alright, now, I take it, then, that since this is an academic approach to the problem that we have here that that is the reason that you used the mathematical angle rather than the geological angle, is that correct?

A. I don't know how to answer that.

Q. Well, all right. Now, Mr. Hammer, I think it will clarify one thing, at least, and that is this coming up proposition that we are talking about. It just happened a lot later than last week, didn't it, this question of the academic problem coming up instead of you coming up?

A. The whole question there, Mr. Keffer, is this: In a problem of that kind and where I devoted most of my time because I had to in working out the problem relative to the western part of the area in which Canadian River has its acreage, there always was a question in the back of my head whether I should use that or whether I should not use it, and that was another point of this academic thing we are talking about, whether to use that figure or whether to not use it was an open question.

Q. Yes, but the point is you have computed the entire reserves of the field with Wheeler County quadrant in, included in the last ten days.

A. No.

Q. About how long ago was it?

A. Oh, I don't know. I have worked at it off and on whenever I could find time and gather a little information, pick it up here and there, and could get it together. I wouldn't know how long.

Q. Well, this thing just came up, I should say not more than ten days or two weeks ago at the outside.

A. Well, it has always been a problem.

Mr. March: I object to counsel arguing with the witness. I don't object to him asking the witness questions, but this is argument. The witness stated at the beginning with regard to Wheeler County when he asked him to give what the field reserve would be he said way back yonder he might have made the calculation but he couldn't tell, he didn't know. He has been doing some thinking about that and all these things are argumentative.

Mr. Keffer: All right. All right, if you will stop, I will.

Mr. March: All right.

By Mr. Keffer:

Q. All right, now, you have given us the weighted average pressures as you have computed them, Mr. Hammer, during the period which you covered in your study. Now, you check with me. It was yesterday that you gave these, your pressure—

A. May I see your sheet a minute so I can see what you are talking about?

Q. It is the weighted average pressure for the five points; that is, five pressure dates.

A. I gave those to you, all right. They are in the record.

Q. Yes, I just wanted to remind you what the figures were.

A. But I don't think I have the sheet I gave them to you from.

Q. You might take the figures down, then, as I read them back to you, because I want to make a similar calculation. All right, we'll take the weighted average pressure as you calculated it, Mr. Hammer, on August 1, 1935. That's the 369.25 pounds. Now, this is for the field as a whole with the Wheeler County quadrant out.

A. That's right.

Q. On August 1, 1936, 360.74.

A. All right.

Q. August 1, 1937, 352.02.

A. All right.

Q. August 1, 1938, 343.01.

A. All right, that's right.

Q. August 1, 1939, 332.98.

A. Read that again, please.

Q. 332.98.

A. That's right. That sounds right. They were read into the record. I read them in myself, I think.

Q. Now, from 1935 to 1936—August 1, 1935 to August 1, 1936, that gives you a pressure drop of 8.51 pounds, wouldn't it?

A. Just a minute, Mr. Keffer. I happen to remember that I do have the figures here and I just want to check them from my other notes.

Q. All right.

A. Yes, those are correct.

Q. All right, and the pressure drop from 8-1-35 to 8-1-36 would be 8.51 pounds, is that correct?

A. 8.51.

Q. 8.51?

A. That's right.

Q. And from August 1, 1936 to August 1, 1937, 8.72.

A. That's correct.

Q. August 1, 1937 to August 1, 1938, 9.01.

A. 1937 to 1938?

Q. That's right.

A. That's right.

Q. August 1, 1939—August 1, 1938, rather, to August 1, 1939, 10.03?

A. That's right.

Q. Now, that shows an acceleration in drop from year to year, doesn't it, Mr. Hammer?

A. Yes, it does there.

Q. Each year the pressure drop has been a little more than it has the year before, hasn't it?

A. Yes.

Q. All right, could you not expect the pressure drop to be a little more the next year than it has been this past year?

A. It all depends on the question of withdrawals.

Q. The question of what?

A. Withdrawals, gas taken out.

Q. Yes. Well, just what do you mean by that?

A. I wouldn't want to guess what it would be in the future.

Q. Well, say the production is the same as it was from August 1, 1938 to August 1, 1939.

A. If it would get back and settle down to a more or less definite withdrawal over a period of years, I think that that annual differential would also settle down to a very definite figure.

Q. Well, what do you mean by a very definite figure?

A. Well, I can't tell, whatever it would be.

Q. You just don't know, then? Is that right?

A. Well, I know what happened here.

Q. That's right.

A. All right. The point I make is that you have had an increasing withdrawal there for those years.

Q. And you account for those increasing pressure drops solely from increasing withdrawals, is that correct?

A. I think that is the largest factor.

Q. Well, then, I take it if production would go up, certainly you agree with me on that, then your pressure drop would increase, wouldn't it?

A. It might. It probably would. That's right, on the average.

Q. Well, now, do you want to say it would or it probably would or approximately so, or which?

A. Read that.

(The question referred to was read by the reporter, as set forth above.)

The Witness: Well, I'll tell you. I'll answer that this way; When you go from year to year over that short a period of time in a field as large where you take a field as large as the Panhandle field and you take out a lot of gas during one year, when you consider the field as a whole you will probably have, and in fact I am sure you do have, certain areas where because of low permeability factors the gas pressure does not build up rapidly in the wells; so to go to work and make a general assumption on what might happen in the future when you have all the factors entering into it, as far as I am concerned, I am not making any such statement at all. There are just too many unknowns that enter into it. There is nobody can predict what is going

to happen, but on the average it is true that withdrawals have their effect, but that is not only the effect; so that I won't predict what is going to happen in the future.

For instance, some of you fellows might suddenly decide it would be a good idea to go up to Hugoton and start taking a lot of gas and you might not take so much out of the Panhandle. You would have a different picture. There are so many factors that I am not predicting.

Q. You are not predicting that we are going to do that, are you?

A. I wouldn't be surprised.

Q. Now, do you want to base any of your estimates on that prediction?

A. No.

Q. Well, that's just an observation which has no particular weight in this record, is that correct?

A. That's right.

Mr. March: The same as the question. The answer was the same as the question.

Mr. Keffer: All right, Mr. March.

Q. Now, just taking that a step further, you do know, don't you, Mr. Hammer, that as pressures go down from year to year at an accelerated rate that you can expect that acceleration to continue in future years?

A. No, I won't—

Q. How's that?

A. I won't adhere to that assumption at all for the reasons I have explained. These pressures here are—some of them—these drops in pressure are probably artificial. In other words, you take an area of low permeability and you draw heavily on that well and what do you get? You get a low pressure. It may not have taken out a very large volume of gas because the gas couldn't move into it fast enough.

Q. All right.

A. The result is you get an artificially low pressure which would be reflected on this, so that you can't predict—

Q. All right, now, are you stating that as a fact?

A. I am stating that as a fact.

Q. All right, give me the wells in which that happened.

A. I can't give you the wells but I can give you localities.

Q. Do you know what pressure is subnormal—

A. What was that?

Q. How do you know that an accurate pressure as reflected by the pressure figures that you got from the Texas Railroad Commission are accurate?

A. Read that question.

(The question referred to was read by the reporter, as set forth above.)

The Witness: I recall definitely that on your own leases on your quadrants right down here in Moore County, in the center of that quadrant—

Mr. Spencer: Moore County?

The Witness: Potter County. I beg your parden—Quadrant 1, Potter County, in 1936 the pressure around your wells in the center of that went away low and what happened, it took almost the entire year for those to get back up to anything like normal, and what is the ultimate result? That low that developed in there in 1935 and 1936 was not entirely up and it took a long time for that gas to move in to build that pressure back up.

By Mr. Keffer:

Q. Now, will you please answer my question, Mr. Hammer, which is this: Do you know of any well in which the pressure which you utilized was not the accurate pressure? That was my question.

A. No, not the accurate pressure at the time it was taken, but it did not represent the true condition.

Q. Well, wait a minute. What sort of a pressure represents the true condition?

A. Well, if you took a well just as I have explained there—

Q. Yes.

A. Or an area or a group of wells—

Q. That's right.

A. —and you pull heavy on them and your pressure goes way down, then you follow that thing through and find out it takes a long time for that pressure to build back up. The answer is that that local pressure did not reflect the pressure of that area at all.

Q. All right, and threw you off on your pressure decline application?

A. No, it didn't at all.

Q. Why didn't it?

A. That was all weighted out.

Q. How do you mean, it was all weighted out?

A. Just as explained before. There is no use to go into all that again.

Q. All right, in your own assumption. Going back to the question I asked you some fifteen minutes ago, if you have the progressive declines in pressure accelerating from year to year, then it does mean something, on your own statement, because you said you have weighted it all out.

Mr. Lange: I object to that question because it presumes that the witness states, and which he did not state, that the pressures declined at an accelerating rate, which the witness has denied. The witness has denied that. You have assumed in your question that he has first answered the question affirmatively and I object to that question and ask him to reword his question for this reason. He can ask the witness whether they are accelerating or declining or not.

Mr. Keffer: I didn't think he had. I will ask him that.

Q. Are the pressures declining at an accelerated rate in the Panhandle field from year to year?

A. The records indicate that they are.

Q. They are? I thought so.

Now, Mr. March, do you want to apologize to me or not?

Mr. March: I thought you meant incremental pressures.

Mr. Keffer: I don't know what you mean by incremental pressures. Watch my questions and you will get what I mean, I think.

Q. All right, then, since they are dropping progressively from year to year, is it not a fair assumption that that will continue?

A. Well, as I said a while ago, I don't want to predict what is going to happen to pressures.

Q. Well, don't you have to predict that to apply your method and test it?

A. No, not into the future, not as far as pressures are concerned.

Q. All right, your method assumes that the condition is not going to change doesn't it?

A. My method?

Q. Yes, sir, the application of the pressure decline method.

A. No.

Q. All right, what changes have you assumed, then, for the future in the application?

A. I have assumed that gas withdrawals will continue according to straight line calculation. In other words,—

The drop in pressure in relation to the volume removed will in the average continue as it has in the past.

Q. Well, do you mean to say by that, then, that your drop in pressure must be geared entirely to production figures and that is the thing that determines the drop? Is that what you are trying to say?

A. Well, I am trying to say that, as I have already mentioned, that there are other things that throw your pressures off.

Q. But you said you had weighted all those out.

A. All, right, I have weighted them out and in my calculations the future is a straight line. It is not an incremental curve that goes down.

Q. That's quite true.

A. All right.

Q. Now, if the past is not a straight line, why would the future be a straight line?

A. The past is a straight line as far as the proper interpretation of the data is concerned.

Q. Well, the past isn't a straight line as a matter of fact, when you plot it on a paper, is it?

A. If you just take pressures alone, and I haven't plotted the thing—wait a minute.

Q. Be careful what you are doing.

Mr. March: We went over all that once. Does the Examiner want to hear it all over again?

The Trial Examiner: That's about what I was going to say, Mr. Keffer. Didn't we also cover this yesterday on cross examination? I don't want to interfere but—

Mr. Keffer: I don't think we did as applied to specific pressure data. I don't think so.

Mr. March: Oh, yes, you did. You took this big curve here.

Mr. Keffer: All right, then, if we have we will eliminate that. That was on Canadian River. I am talking about the field now.

Mr. March: Well, he doesn't have a curve on the whole field.

The Witness: Yes, I remember that in my notes here—I just happened to recall that I have got a curve for the field—I don't mean that, but I have a curve here covering 1935, 1936, 1937, 1938 and 1939, with the accumulated production for the entire field plotted against it, and I submit to anybody that that thing follows almost a straight line when plotted through those points, when you plot your pressure drop against your accumulated production.

Mr. March: Is that in your working papers?

The Witness: That is in my working papers. It is some notes that I had here and I happened to remember that I had that with me.

Mr. March: That is not a part of your exhibit?

The Witness: That is not part of my exhibit.

Mr. March: We haven't offered that as an exhibit?

The Witness: No.

Mr. March: There is no use talking about it, then, Mr. Examiner.

Mr. Spencer: The witness wants to talk about it, Mr. March. Let him go ahead.

The Trial Examiner: He brought it up, Mr. March.

Mr. March: Go right ahead, then.

The Witness: This particular thing I wanted to bring out, it wouldn't go clear on out, but it does prove that the—if you take these pressure declines he is talking about and plotted them against the accumulated production, there is your story, and it is a straight line.

By Mr. Keffer:

Q. Now, you said "straight line." It is a straight line because you drew it straight, isn't it?

A. Well, any engineer would draw it that way.

Q. Answer the question.

A. That's right.

Q. It is a straight line because you drew it that way, isn't it?

A. Any engineer, including myself, would do it.

Q. And if you went through the center of your points it would not be a straight line, isn't that a fact?

A. Yes, if you went through them, but that is not the way it is done. It is not the way anybody would do it that knows anything about his business.

Q. Let me show you another curve that is drawn exactly on the points and look at that and compare it with yours.

A. That is on pressure only.

Q. What's yours?

A. Mine is pressure against accumulated production.

Q. All right, where is your accumulated production?

A. It shows here. You can read it off the bottom, "The accumulated production, August 1, 1935, in Mcf."

Q. Well, what is it?

A. All right, this line here is 250. This would be something like 240 something. In other words, if you will check it you will find that figure I gave you at 240.

Q. What? thousands, millions, billions, or trillions?

A. It is in billions of cubic feet.

Q. Well, then, that's two trillion five hundred some odd, as you have it there.

A. Two trillion, five hundred billion, that's this particular line here, yes.

The 1935 to 1936 production was 650 billion cubic feet with a 8.51 pound drop in pressure. The next year, 1936 to 1937, the production was 600 billion cubic feet, and the witness would have expected the pressure drop to have been a little less, but, as a matter of fact, the pressure drop was a little more.

The next year the production was 616 billion cubic feet which should have indicated a little increase in the drop from the year before, and, as a matter of fact, there was a little increase, and the next year, 1938 to 1939, there was a production of 598 billion cubic feet. This production

was considerably less than the 616 billion cubic feet for the year before and was the smallest production for any of the periods. This being true, the witness would have expected a still smaller pressure decline when the matter is viewed from year to year, but, as a matter of fact, the loss in pressure was 10.03 pounds, the greatest drop for the entire period.

The witness further testified (Vol. 59, pp. 8368-8404) as follows:

Q. Then, production didn't determine pressure drop, did it?

A. There is no use to go into it again, but we will go into it again—

Q. You said a while ago it did.

A. I said there were qualifications—

Q. You got the qualifications into the record, I take it?

A. I said there were qualifications on this point.

Q. And the record speaks for itself. Let us have the record stand as it is.

When you plot a straight line, however you determine it, when ever you take the actual data you have here, you couldn't have a straight line regardless of what your paper shows there?

A. No, that isn't true.

Q. We will let the record speak for itself.

A. That is right, I can't calculate from year to year and get anything like a fair figure.

Q. All right, would you mind extending this curve for me about five or six years?

A. No, not unless the Examiner orders me to do so.

Mr. March: We object to that. We have gone far enough. This comes up and shows exactly what he has been getting at here. This is "Annual Pressure Drop, Panhandle Field, Excluding 1, Hammer's Data, Years." Now, he wants us to come along and he already thinks he is getting this exhibit put in through our witness, these curves plotted with our witness' data. Now, he wants the curve fixed up a little further along that line. We object. That is exactly in point with the Examiner's ruling. We have gone over fifty-five per cent of the way—

Mr. Spencer: Fifty-five per cent of the way?

Mr. March: One hundred per cent of the way.

Mr. Keffer: Most everyone has seen this chart. I will show it to the Examiner.

Mr. March: That is what you say it looks like.

Mr. Keffer: So does Mr. Hammer.

Mr. March: No, the witness didn't say that. You are plotting year for year—

The Trial Examiner: Never mind. The record will speak for itself.

Mr. Keffer: I will ask Mr. Hammer one more question.

Q. As a matter of fact, if that had been plotted against production as you say you did it, it would have been more extreme than what is shown in there, wouldn't it, Mr. Hammer?

A. No, that is not true.

Q. You are getting an increased drop with less production.

A. Yes, but as I have just stated, you can't do that from year to year.

Q. That is what you did?

A. No. I took a five-year period here.

Q. Five years?

A. I put those points on this curve pressure decline against accumulated production.

Q. That is right.

A. All right.

Q. If you put them on this curve against accumulated production you would have a curve dropping faster than this one?

A. No, that is not true.

Q. Take the last year, in 1938-1939, that is the fastest dropping point on the curve?

A. For one year only.

Q. That is right, and that was the least production?

A. All right. I have just explained how the—where you take the pressure on a group of wells you don't get a true pressure factor.

Q. But you have already stated you weighted all that

in, accounting for all of that, so there isn't any error in your own statement—

A. Yes, and I got a straight line curve through because I did it.

Q. What are we talking about?

A. You are taking something entirely foreign where you haven't used accumulated production—

Q. The point is—

A. —and where you haven't weighted out anything except for one year. You haven't taken an average of what happens over four or five years.

Q. We have the whole thing. So, yours is based on an average, is that it?

A. It is based upon an accumulated production as determined—

Q. Averaged out over the period?

A. No, it is worked out exactly with the same principle with the field as a whole on this curve, as it has been used on all these quadrants, that is all.

Q. Now you say—

A. You get the best slope through a series of divergent points.

Q. The whole point is—that is all right. I won't go into that any further.

Mr. Hammer, you say that low pressure areas throw you out of line somewhat, is that the point?

A. What I mean is this—yes, and no.

Q. Which one?

A. Wait a minute.

Q. All right.

A: In the study of this pressure situation we noticed that where wells in areas of low permeability have been pulled on heavily that there would be a rapid pressure drop clear out of line with anything else around in the same territory and it might take some little time for that to build up. Well, now, if the Railroad Commission's men had happened to come along and take those pressures on those wells right after there had been heavy withdrawals locally, they would have had a pressure that wasn't at all indicative of what that should have been.

Q. Is that what the Railroad Commission did?

A. In relation to the volume removed.

Q. Is that what the Railroad Commission did?

A. There is some evidence, yes, in places where they did do that.

Q. What is the evidence?

A. I don't have all those things here.

Q. Give me just one or two of them as illustrations.

A. I gave you one in your own acreage.

Q. That wasn't in 1939, was it?

A. When?

Q. That wasn't in 1939, was it?

A. No.

Q. All right, what did it represent to you? What did it tell you?

A. Do you mean during when you had that extremely low pressure?

Q. When you say "extremely low," how low was it? That is a relative term.

A. It is a relative term.

Q. How low was it?

A. I would have to get that information.

Q. It was about 380 pounds, wasn't it?

A. Well, what I meant there by "relative," was that it was extremely low as compared with the area immediately adjoining it.

Q. Several miles away from there you had a pressure of around 390 or 400 pounds?

A. Yes, they are high in close to it.

Q. How close?

A. Oh, I would say—let's put it this way. Just assume —I don't remember—that your pressure was 380 that you took.

Q. I think some was more than that.

A. For the purpose of illustration I will assume it was that.

Q. All right.

A. If you take a 10-pound isobar, say, take your 390, the total slope where you would get up to—rather, the pressure differential gradient wouldn't extend out, according to my memory of it, to exceed two miles from the well at the most.

Q. You say that is from your memory. How good is your memory on that?

A. Well, I think that is about right.

Q. As a matter of fact, didn't it extend out several miles?

A. No, I don't think so.

Q. You don't think so?

A. No.

Q. Didn't it extend out several miles as shown on the Railroad Commission's map?

A. That isn't the way it looks when you get a map on 10-pound isobars.

Q. I am just looking at one here and I don't see anything about it.

A. That is for 1939. I was talking about 1935.

Q. It was the one you left in Washington, I take it?

A. That is right.

Mr. Keffer: That is all for the morning session, Mr. Examiner.

The Trial Examiner: The hearing will stand in recess until 2:00 o'clock this afternoon.

(Whereupon, at 12:30 o'clock, p. m., a recess was taken until 2:00 o'clock, p. m., of the same day.)

Afternoon Session—2:00 P. M.

The Trial Examiner: The hearing will be in order. Whereupon—

A. A. Hammer

the witness on the stand at the time of recess, having been previously duly sworn, resumed the stand and testified further as follows:

Cross Examination (Continued)

By Mr. Keffer:

Q. Mr. Hammer, we were discussing a while ago the pressure drop field-wide in the Panhandle, it was increasing from year to year, that is, during the entire period covered by your study the pressure drop increased in every instance, in no one year greater than it had increased the preceding year, is that correct?

A. There had been an increase.

Q. That is right. That happened without an increase in production. In fact, your greatest pressure drop in any one year, which was the last year, showed the smallest production in the period, didn't it?

A. I think that is true.

Q. All right. Now, you have tried to draw a straight line reflecting that matter when as a matter of fact your actual factual data doesn't show a straight line, does it?

A. It does when properly drawn.

Q. Well, it is properly drawn when you put it right on your ordinate points, your graphic point, isn't that true? That is proper and that is actually what it is, isn't it?

A. Yes, it is, the way I drew a curve. That is actually what it is.

Q. That is actually what happened in the field?

A. Yes, where I plotted my dropping in pressures against the accumulated production, that over a five-year period is actually what is happening to the field.

Q. As you plotted it you didn't show an accelerated drop from 1938 to 1939, did you?

A. On the actual points, if you take it from one year to the next without consideration of anything else, it showed it there. In other words, if you draw one of the crooked curves you are talking about, to which I don't agree, but if you drew it that way you would have a curve that followed divergent points.

Q. You say if I drew it my way. My curve on the exhibit presented to you was represented by actually what happened in the field. There wasn't any judgment about it. That is exactly what it was.

A. You are talking now about the curve you drew?

Q. Yes.

A. You left out one of the very important factors there in the projection of the curve.

Q. What?

A. You simply drew a curve on pressures against years.

Q. The pressures against years, that is true. It showed what was happening each year.

A. As far as pressures alone are concerned, I will agree with you.

Q. All right. Since the production from August 1, 1938 to August 1, 1939 was the smallest production in the volume of the entire period covered by your study, and since the pressure drop without production being considered was the greatest, and the production had been plotted in there, too, as you did it, the slope of the line from August 1, 1938 to August 1, 1939 would have been more decided than what I showed, wouldn't it?

A. If you take one year, but I have repeatedly said that it isn't a fair way to judge a field of this type or any other field.

Q. Well, I know you have said that.

A. It is true.

Q. If you take a period of years and you get a trend and you see that each year is getting more and more and more, then do you think you can ignore that trend?

A. I haven't ignored it. All I have done is to weight it out and get a fair curve.

Q. What you did was to just draw a straight line through that?

A. It is a straight line, that is true, and that is the line it should be.

Q. You say it should be. How do you know it should be a straight line?

A. That is the way any engineer in the world would draw it?

Q. Why should it be a straight line?

A. Because in order to get a fair answer you must take into consideration not what happens in one year but what happens over a period of years.

Q. Take it over a period of years, still you don't get a straight line, except you arbitrarily make it a straight line with a straight-edge ruler.

A. That comes right back—

Q. You take your own points. You don't get a straight line if you connect your points—

A. If you connect it from point to point, of course you don't.

The Trial Examiner: Through the center?

Mr. Keffer: Through the center.

Q. How do you know that line ought to be straight?

A. It has to be straight.

Q. Why?

A. Any line has to be straight under conditions and under the method which we have employed, that is, the application of Boyle's law.

Q. Why does it have to be straight? Please answer my question.

A. The volume removed always bears a direct relationship to the drop in pressure.

Q. Yet it isn't straight when you connected it from point to point and center to center?

A. Well, those divergent things always come in in any field, but it has always been the practice, and it is the practice now of the great majority of geologists and engineers who employ the pressure decline, to utilize that same principle of arriving at a slope for their curve.

Q. What principle?

A. Well, the principle of getting the best slope that you can through a bunch of divergent points.

Q. The principle of getting a straight edge and drawing a straight line through there where you want it to come out?

A. That is not true.

Q. Isn't that what you actually did?

A. I drew it where the average weighting of the four years of pressure and the five years of production said it was the closest possible to get it.

Q. And you ignored the accelerated drop from year to year?

A. Let's go back a minute. If you had drawn a curve between 1937 and 1938 you would have had a slope that would have given you a different one, wouldn't you? Certainly it would. It would have given a very much larger indicated production than would be the true figure, taking it over a period of years.

Q. Tell me what that would have given you. Would that have given you the indicated production if you had drawn the slope between 1937 and 1938?

A. Well, you would have had a less drop in pressure—

Q. I know, but I want you to give me the figure. It is a very easy figure to get. I can work that problem myself.

A. Between 1937 and 1938, you say?

Q. Yes.

A. Well, your actual drop between 1937 and 1938 was 9.01.

Q. All right, 9.01. What is your production for that period?

A. I believe I gave you the accumulated production.

Q. The accumulated production for that year?

A. May I have that document you have there? I don't seem to have mine with me.

Q. I will give it to you. It is 616,439,219.

A. Read that back to me. I couldn't keep up with you.

(The question referred to was read by the reporter, as set forth above.)

Mr. Keffer: All right.

Q. Now divide your 9.01 into your production for that year.

A. May I leave off the .01? It would be easier to use just the figure 9.

Q. I will tell you what we have done. We have figured it out accurately here, Mr. Hammer, and to save time let's get it into the record and the basic figures can be checked very readily.

You divide 9.01 into the 616,439,219 and you get an average production per pound drop in pressure of 68,417,227 cubic feet. That is not Mcf. but cubic feet. You multiply that by 430 and get a calculated original field reserve of 29,000,407,610 Mcf.

In other words, it is 29 trillion plus.

A. Yes.

Q. Let's look at your graph again.

A. My graph won't take that in because it was only illustrated to cover the five-year period.

Q. I understand that. What calculated field reserve does your graph show?

A. I said this isn't projected on through.

Q. Project it on through and see what it shows.

Mr. March: We object to that, if the Examiner pleases. That is another little mathematical problem he wants him to work out for him.

Mr. Keffer: Anybody can project it. It is perfectly a straight line and all you have to do is to run it out.

Mr. March: I guess if anybody could, you could bring a witness here and have him do it.

Mr. Keffer: Even you could do that, Mr. March.

Mr. March: We object to that, Mr. Examiner.

The Trial Examiner: What was the statement you were about to make, Mr. Hammer?

The Witness: This only illustrates that if you could properly project that curve not into the future but through the five years of data that we used, it follows a straight line. That is the object of putting it in properly projected. It wasn't ever projected into the future. It would take a lot of additional and coordinate paper and different scales, and it would be a job that would have to be done all over.

By Mr. Keffer:

Q. As a matter of fact, Mr. Hammer, as you did on *some of the* Canadian River's exhibits, all you have to do is come back and keep drawing straight lines and you would have it there. You haven't any deviation in it and you say it is already figured out correctly.

A. It would take quite a little time to do that. I doubt whether the scale laid out here—no, I know you couldn't get it on there. You wouldn't have room.

Q. Does that include Quadrant 1, Wheeler County, as you have the line drawn there?

A. Well, I don't know whether it does or doesn't from looking at this sheet. I think we can check it from those accumulated figures in the field which I gave you.

Q. Tell me how you constructed it. That would give the facts.

A. This was constructed in Washington from the field data and I might have already given you that accumulative production.

Q. Go back in your working papers and get the basic data for that graph and see what it is. See if it is interpreted the same as those figures you gave me.

A. That would take time.

Q. You would just have to read a page, that is all. That is a very small thing to do. Just look in your working papers and see what pressure you had here rather than looking on this graph. See what your production figures were.

Mr. March: If the Examiner pleases, it may be that we will offer this as an exhibit. This has nothing to do with the computation of the reserves and the exhibit which has been offered. That merely is something that is illustrative of the results. It has no bearing upon arriving at the results. It is a check. This whole discussion was volunteered by Mr. Hammer in regard to the whole field and it wasn't

prepared as an exhibit. Commission's counsel hasn't offered it as an exhibit, however, at which time it does you will be entitled to all of the data surrounding it just as you have been entitled to the data surrounding Exhibit No. 180.

In Exhibit 180 the same type of curve is found on Page 4-B which the witness has been cross examined about, and there is a sheet in there giving the details as to how that curve was arrived at. I will assure Mr. Keffer that when that is offered as an exhibit he will be entitled to test it completely. That was something volunteered by this witness which Commission's counsel did not offer as an exhibit.

There is another one just like it in the other exhibit you have already asked him about, Mr. Keffer, Exhibit No. 180, involving the Canadian River's acreage.

By Mr. Keffer:

Q. Mr. Hammer, we were discussing this matter yesterday and you gave your original field per acre as 72.2 billion cubic feet per pound drop in pressure, didn't you?

A. For what?

Q. For the entire period which you have considered.

A. Well, I don't know offhand. The record will show what I said or what was brought out. I don't remember it now.

Q. All right, you gave us a figure—your ultimate reserve figure, as you call it—at 25 pounds abandonment as 29,277,—

A. Yes, that is my recollection.

Q. You don't know whether that included Wheeler County quadrant?

A. From memory, I don't.

Q. You don't recall?

A. It would only make 700 billion difference anyway.

Q. Yes, you said that. That 29,277,000,000,000, the round figure you gave, represented a production of 405 pounds out of the reservoir down to the 25-pound abandonment?

A. Yes, if you take 430 as the original pressure.

Q. Isn't that correct? Isn't that what you have taken?

A. That is what I have used. There has always been a doubt in my mind whether it is true, but I have used it.

Q. You have used it?

A. That is true.

Q. You divided 405 into 29,277,000,000,000 and you got 72.2 billion?

A. I haven't divided it out.

Q. The round figures were given here and it is a very simple calculation to divide it out. See if you can't do that.

A. What are the figures?

Q. I think you did it yesterday and I think the record already shows it.

A. 29,277,000,000,000?

Q. That is right.

A. Divided by what?

Q. 405.

A. It is 72 plus.

Q. I have 72 plus, too. Does that look about right? I think that is about where you would hit it.

A. It is closer to 72 plus.

Q. 72 plus 2. All right, that is the production per pound pressure drop that you got on your calculation; it might have included Wheeler County quadrant or not. That is the only questionable thing about it.

A. It is so small in relation to the whole it wouldn't make much difference.

Q. All right, let's keep that figure in mind, Mr. Hammer, and go back to that pressure drop from 1937 to 1938 where you had a 9.01 pressure drop which the record shows. If we divided that into the production of that year of 16,439,219 Mcf., would we have gotten the pressure drop of 68,417,227 as against your 72 million plus?

A. That would be right if you want to make that comparison.

Q. All right, then, we go back to the year 1936-1937 when you had an 8.72 pressure drop as against 600,013,041 Mcf. and divided your 8.72 into that. You get a production per pound pressure drop there of (copy illegible) 68,808,835 Mcf., is that right?

A. I don't know whether it is right as I haven't figured it.

Q. Anybody can figure it from the record. All of the basic figures are there.

Mr. March: Mr. Examiner, this is doing exactly what I said was going to be done and I think it is contrary to

the Examiner's ruling. He has taken his computations and is trying to get this witness to agree to them.

Mr. Keffer: I have taken the basic figure which we agreed upon and I have given him my computation.

Mr. March: That is the point. The Examiner's ruling was he would have to do it through his own witness.

You went half-way with Commission's counsel, Mr. Examiner, in stating that you would instruct the witness to check the actual figures that were taken off of his working papers, but you would not require the witness to approve or disapprove or compute the computations made by counsel here and his associates as to the results therefrom.

Mr. Keffer: I gave an assumed figure which he can come back to later.

Mr. March: I object to that line of cross examination because it is improper and it doesn't mean a thing in the world. This witness can't compute all this on the stand here. If he wants to bring in this other estimate, if he wants to do it a different way, he can bring it in here through his own witness.

Mr. Keffer: I am doing it Mr. Hammer's own way. I have been trying to point it out all the way through this cross examination. These are his figures.

Mr. March: That is the point, Mr. Examiner. In spite of the Examiner's rulings he will say that all of this is Mr. Hammer's computations, the results therefrom, he approved everything, which is not the correct situation.

The Trial Examiner: I think, of course, the important thing is that the computations be correct.

Mr. Keffer: They will be self-evident, Mr. Examiner. All of the figures are there where anybody can divide it out.

Mr. March: Mr. Hammer's working papers are not in the record.

The Trial Examiner: I don't know, Mr. Keffer. It seems to me that it is rather burdensome to the witness to have to check those amounts.

Mr. Keffer: May I make this statement, Mr. Examiner?

The Trial Examiner: Yes.

Mr. Keffer: Assuming my calculations are correct, the figures are in the record where the Examiner, Mr. March, or anybody can check to see whether I made them accurately, just as though I would say we have 2 and 2 over here and it makes 4. Mr. Hammer doesn't want to say that 2 and 2 makes 4 but the record is clear and that is precisely—

Mr. March: He takes a piece of wood from over here out of this wood and takes a piece of wood out of here and makes this building but it is his child and not our child. It is not proper cross examination, Mr. Examiner. It is contrary to the Examiner's ruling that was made today.

Mr. Keffer: These pressure declines and production figures are the identical figures which Mr. Hammer has already given. There is nothing to assume about those as they are in the record.

Mr. March: We may want to cross examine the man who says they and his results—

Mr. Keffer: That is the same. Your own witness gave them.

Mr. March: That is the point. They can put on their case when they come back on. This witness can be cross examined on this exhibit but when they bring up a new exhibit, one of their own brain childs, and cross examine our witness in regard to it, attempt to have him stipulate as to the computations—we will stipulate as to it when they take his figures off the working papers—but when you go to computing from their exhibit it goes beyond the realm of proper cross examination.

The Trial Examiner: I do think this: The basic figures, you have verified those through Mr. Hammer. Now, as to the computations made from those figures, I am not inclined to view them as improper or erroneous, but at the same time I am hesitant to thrust that burden upon Mr. Hammer to satisfy him—

Mr. Keffer: I wouldn't ask Mr. Hammer to do that. It will be entirely up to him as to whether he wants to do that.

Mr. March: He wants to put the witness into a position

of where he has to say yes or no to something he shouldn't even be cross examined about, a new exhibit that is different altogether. He wants to come through the back door and put in an exhibit which is not ours. If he wants to put in an exhibit, let him bring his own witness in here.

Mr. Keffer: Let me make one statement, Mr. March. I could have said it in half this time, half the time we have been talking here. Mr. Hammer has made the statement many many times that he has taken a conservative course. In one or two more questions I can prove not only that he did not do that but he took the highest figure he could get out of a group and didn't average anything. If that isn't legitimate cross examination I don't know what is.

Mr. March: That is his argument, that he did, and Mr. Hammer denied he did. If he has any witnesses, which he has, let them figure that out. If those geologists use Mr. Hammer's figures and figure it out that way, in all righteousness he should have nerve enough to put those geologists on the stand here and let us cross examine them.

Mr. Spencer: We have plenty of nerve, Mr. March.

Mr. March: I will say you have.

The Trial Examiner: I take it, then, Mr. Keffer, for the purpose of further cross examination it will be necessary that this computation that you speak of be used?

Mr. Keffer: I am not sure that I understood the Examiner precisely. The only figures we need, Mr. Hammer has already given us. I am cross examining him as to the accuracy of those figures. He has given them and I am taking those figures. It is a mere matter of taking a certain figure by the pressure therein and multiply by 430, which he said was the way to do it, which the Examiner could do—any of us could do that, and I am putting those basic figures in and saying that this is what it shows. It is there for anyone to check who questions it. I am not asking Mr. Hammer to do a thing.

Mr. Spencer: Mr. Examiner, before you rule, may I put it another way. Mr. Keffer has tried to expedite this hearing but suppose Mr. Keffer would ask the witness this question: "Mr. Hammer, take your rock pressure decline for a specific year, also your production for that year, and

tell me what the indicated reserves are for the field base upon that year," would the Examiner rule that question was not relevant and not material? It is using his own figures for that year, asking merely the question as to what the indicated reserves are for the field, based upon that year.

Mr. March: The way he figured—now he is cross examining the Examiner.

Mr. Spencer: That is what we are getting down to.

The Trial Examiner: I think I have expressed myself on that before, Mr. Spencer, the relevancy of that particular thing, but we are coming now to a point as I see it—maybe I have the wrong slant—where Mr. Keffer I believe requested Mr. Hammer to make a certain calculation—

Mr. Keffer: I am not going to ask him to make a calculation.

Mr. March: Some calculations have already been made by him. It is the same old horse.

The Trial Examiner: In order to verify the calculations —as I say, I don't feel it is improper cross examination, but at the same time I am not concerned about Mr. Hammer having to verify—not "verify," but having him to affirm a figure that is submitted to him.

Mr. Keffer: I am not asking him to affirm a figure.

The Trial Examiner: Just what are you asking him, Mr. Keffer?

Mr. Keffer: Let's proceed—

Mr. March: Let's don't proceed. After the horse gets out of the corral there is no use of corraling the horse.

Mr. Keffer: In order to protect our record I am going back and ask these questions one by one, and since the objection has been made that they don't want any calculation, I am not going to give a calculation I have made but I am going to ask Mr. Hammer to make a calculation in order, as I have stated, to protect our record in this matter. I am perfectly willing as far as I am concerned—

Mr. March: Either way is the same.

You ruled this morning, Mr. Examiner, that you would permit him to verify any of his actual figures taken from his actual working papers, but when it came to making him calculate or verify calculations from those figures furnished by counsel here, you said that was something that you would not insist the witness comply with.

The Trial Examiner: I believe I said, Mr. March, that I would not require him to affirm the accuracy of the calculations made on the particular sheet to which you were referring this morning. Let's go along and see what develops, Mr. Keffer.

Mr. Keffer: All right.

Q. The pressure drop as you have heretofore stated, Mr. Hammer, from August 1, 1935 to August 1, 1936 is 8.51 pounds average for the field?

A. Yes, that is right.

Q. The production from August 1, 1935 to August 1, 1936 was 615,778,940 Mcf. as you have stated?

A. I don't have the figure but I will assume that is correct.

Q. Now, Mr. Hammer, what was the production for that year per pound pressure drop?

A. Well, I didn't write that figure down. I didn't know what was coming up here. You didn't say you wanted it calculated, so I didn't write it down.

Mr. Spencer: I think the other method would shorten this a great deal.

Mr. March: I object to that. I want the Examiner's ruling so the record will be clear as to his calculation. I understand that the Examiner's ruling is that he could calculate it—

The Trial Examiner: I haven't ruled anything.

Mr. March: He is just about to start so we want to get our objection in now.

Mr. Keffer: I have asked a question of counsel—

Mr. March: We object. May we have a ruling Mr. Examiner, before he calculates it?

The Trial Examiner: Mr. Reporter, please read back the record starting with that question.

(The record referred to was read by the reporter, as follows:

"Q. The production from August 1, 1935 to August 1, 1936 was 615,778,940 Mcf. as you have stated?

"A. I don't have the figure but I will assume that is correct.

"Q. Now Mr. Hammer, what was the production for that year per pound pressure drop?

"A. Well, I didn't write that figure down. I didn't know what was coming up here. You didn't say you wanted it calculated so I didn't write it down.")

The Trial Examiner: You may answer.

The Witness: Am I to calculate it?

The Trial Examiner: You understood what he has requested you to do, Mr. Hammer?

The Witness: Yes, he wanted me to divide this production from August 1, 1935 to August 1, 1936 by the drop in weighted pressure.

The Trial Examiner: I think I will take a short-cut on this thing. It seems to me like we are wasting quite a bit of time in going through this thing step by step.

Mr. Keffer: That is the only step there is to it.

The Trial Examiner: All right, then.

Mr. Keffer: Did you mean to ask if there would be other questions, Your Honor?

The Trial Examiner: That is what I meant.

Mr. Keffer: Yes.

The Trial Examiner: But you will ask the witness to make the calculation year by year?

Mr. Keffer: I will state what it is and he is to divide 9.81 into that to see that it is correct.

The Trial Examiner: It would seem to me that it would be unnecessarily taking up quite a bit of time on this particular matter as they will be the figures we were discussing a short time ago. As a short-cut to this particular question,

I wish you would again ask it and I will give Commission's counsel an opportunity to object.

Mr. Keffer: All right. Going back, then, to production for the period August 1, 1935 to August 1, 1936 of 615,778,-940, Mr. Hammer's figure, the pressure decline weighted for the field is 8.51; divided into the production gives the total of 72,359,452,000 cubic feet per pound pressure drop. That is all the whole thing is right there.

The Trial Examiner: That is your question, then.

By Mr. Keffer:

Q. Let us assume, Mr. Hammer, that that is correct—

Mr. March: To which we object

The Trial Examiner: Objection overruled.

The Witness: I haven't calculated it.

The Trial Examiner: It will be understood, however, that that figure, in the event it is determined it is erroneous, is subject to correction.

Mr. Keffer: Of course, I am taking that chance.

Mr. March: Also, he is assuming his method is correct.

The Trial Examiner: Irrespective of the method, I mean that the figures should be subject to correction in the event they are found to be incorrect.

Mr. March: We don't want anything to do with these figures.

The Trial Examiner: I understand, Mr. March.

By Mr. Keffer:

Q. Mr. Hammer, that computation was for the year 1935 to 1936. We had already computed it for the years 1936-1937 and 1937-1938 and in each of those years it was 68 billion, plus, as I stated the computation to be, is that correct?

A. Yes, that is what you said it was.

Q. Just one more question and we will be through.

The year from 1938-1939, the pressure drop that years was 10.03 as you gave it?

A. That is right.

Q. And the production for that year was 598,138,886 Mcf. as you gave it?

A. I assume it is. I don't have the figure.

Q. You gave me that figure

A. Well, all right, I don't have the—I don't have anything to check it against.

Q. I wouldn't think you would want to check your own figure. Dividing 10.03, the pressure drop, into the 598,138,886 it gives a production per pound pressure drop of 59,634,979. We will assume that divides out that way, Mr. Hammer.

A. That is your division.

Q. That is right. Upon that assumption when you calculate yours, the basis upon which you calculated the field reserves, you get a pressure drop—I mean, you get a production per acre pressure drop of 72, billion, don't you, plus 72.2 billion?

A. Well, I didn't carry it out. I would say it was 72, plus.

Q. That is right. Now, the calculations we have just made, assuming that they were made correctly, shows your very highest production figure per pound pressure drop to be 72 billion, plus, doesn't it? That is assuming that I calculated it correctly.

A. Assuming that your method of arriving at it was calculated correctly, yes, sir.

Q. And it drops down each year progressively, doesn't it, until in the year 1938-1939 it reaches 59 billion, plus?

A. That is what your tabulation shows.

Q. Assuming that I have figured that correctly, when you say that you took an average of them and came out with 72 billion, that could not possibly be correct, could it? Isn't that obvious?

A. If your calculations are correct there, it would be.

Q. That would be correct?

A. I said it would be obvious if your method is correct.

Q. I used the same method you used a while ago, precisely.

A. No, you did not.

Q. What was the difference?

A. That 29 I gave you as a figure was arrived at by the summation of the calculated reserve by all of the quadrants in the field.

Q. I know. You have stated that a number of times, but still when you calculated the per pound pressure drop, production per pound pressure drop, it was the equivalent of 72 billion per pound pressure drop, wasn't it?

A. Yes, it was 72 according to those—

Q. The statement I made was, if my calculations are correct it is still sound and it was a correct statement?

A. Well, we will say until they are checked that it is.

Q. Let's go to one other phase of this matter, Mr. Hammer. You have already checked your data as to acres and quadrants and as to acre pounds in each year, which was taken directly from your working papers in so far as the Canadian River's area is concerned?

A. I checked all except the totals.

Q. That is correct?

A. I assumed they were correct.

Q. Now, to get the weighted average pressures from year to year of Canadian River, you divided your number of acres into your acre pounds for each year?

A. That is right.

Q. For 1935 that gives you 39.92. That is arrived at by dividing 443,691, the total number of acres in those various quadrants, into 177,440,264 acre pounds?

A. Yes, that is the way you would calculate it.

Q. Then if you had the weighted pressures from year to year on Canadian River's reserves—I don't see how you could fail to have them—we could short-circuit a lot of this, that is, if you will just give them to us, because you had to have them, certainly, when you figured this Canadian River picture, otherwise you couldn't have done it. These are the entire quadrants that the Canadian River acreage is in, which is the way you approached the problem.

A. Well, the weighted average pressures for 1939 are on Table 4.

Q. That is for Canadian River's acreage alone?

A. No, no, that is for the quadrants in which Canadian River's acreage occurs.

Q. I think you are wrong—

A. I know I am not.

Q. Those are weighted pressures for each quadrant but they are not weighted for the area? It is impossible to tell the weighted pressures for the area without weighting those as to each quadrant, that is correct, isn't it?

A. What do you mean by the area?

Q. The quadrants which you considered in making the Canadian River's reserves estimate.

Mr. Spencer: All of them.

The Witness: I never made any such computation.

The Trial Examiner: You mean by that, Mr. Keffer, the group he used in determining one quadrant?

Mr. Keffer: The groups the witness took into account in his balancing operation as stated, to find the Canadian River reserves.

Mr. March: Mr. Examiner, that is all contained and written out in the exhibit.

Mr. Keffer: That is just the point, it isn't.

Mr. March: It isn't?

Mr. Keffer: No.

Mr. March: Why don't you ask the witness whether it is or not?

Mr. Spencer: He has been asking him that.

Mr. March: Did he say it wasn't?

Mr. Keffer: How's that?

Mr. March: He didn't say it wasn't in there.

Mr. Keffer: Yes, he did.

The Witness: I did not. You didn't give me time.

Mr. Keffer: You said you had the weighted average for each quadrant.

The Witness: You didn't give me time to go through it.

Mr. Keffer: I beg your pardon, I thought you were through answering me.

The Witness: They are in Table 3.

The Trial Examiner: Exhibit 180?

The Witness: Exhibit 180.

By Mr. Keffer:

Q. They are separated again. That is the point, they are not weighted. You had them for each separate quadrant but not for the area as a whole?

A. No, I never did that.

Q. On the schedule which I hand to you and which you have already verified, you got it from the group of quadrants by simply dividing the acreage in the total group into the acre pounds?

A. Yes, you could arrive at it that way.

Q. Isn't that the only way you could?

A. Yes, if these calculations are right, you could.

Q. Of course, they are your calculations. You are pretty sure they are right?

A. I am talking about the totals.

Q. Sir?

A. I am talking about the totals.

Mr. Keffer: If the Examiner pleases, in order to have a basis for this calculation I am going to have the tabulation marked as—I don't care whether it is marked as an exhibit. It could be handed to the stenographer to be copied into the record. That is probably the better way to do it.

Mr. March: If there is any exhibit to go into the record that will be identified, we are going to place it in the record. This is the same line of cross examination we objected to a while ago. He even wants to go further. He wants another computation into the record. We wish to interpose an objection to it being placed in the record. It is not being done either in courts or in administrative procedure.

The witness then testified further with respect to the quadrants containing Canadian River's acreage, and there was identified through him and placed into the record the following data taken from the witness' working papers:

			Acre-Pounds				
		Acres	1935	1936	1937	1938	1939
Hartley	II A	32,906	14,113,298	14,112,147	14,047,499	13,952,964	13,928,532
Potter	I	57,588	24,176,000	23,961,000	23,815,000	23,582,000	23,196,000
	II	44,937	18,966,000	18,869,000	18,628,000	18,497,000	18,191,000
	III	33,389	14,198,000	13,985,000	13,938,000	13,847,000	13,607,000
Moore	I	62,173	23,819,359	23,364,975	23,115,452	22,704,031	22,108,761
	II	61,866	25,624,302	25,396,197	24,933,023	24,248,578	23,238,433
	III	56,614	24,212,903	24,061,291	24,005,464	23,878,600	23,574,156
Hutchinson	III	53,967	15,920,702	15,708,405	15,259,718	15,010,397	14,601,992
Carson	IV	40,251	16,409,700	16,175,600	15,929,200	15,472,200	15,160,100
		443,691	177,440,264	175,633,615	173,671,356	171,192,770	167,605,974

The witness stated that the acre pound factor for each quadrant was determined by taking into account not only the production and pressure drop, but by taking into account also the same data for all surrounding quadrants.

The witness stated that the average weighted pressure of all of the quadrants in which Canadian has acreage may be obtained by dividing the total acreage into the total acre pounds, and that if this is done, assuming the calculation is made correctly, the total weighted pressure for 1936 would be 395.85 pounds; for 1937, 391.42 pounds; for 1938, 385.84 pounds; and for 1939, 377.75 pounds, which would show a pressure drop as follows:

1935-1936	4.07
1936-1937	4.43
1937-1938	5.58
1938-1939	8.09

The witness further testified (Vol. 59, pp. 8418-8429) as follows:

Q. For 1937, making the same calculation, it gives you a decline of 4.43 and for 1938 it gives you a decline of 5.58, and for 1939 it gives you a decline of 8.09. Those are based upon the calculations which the record will show. Assuming that those are correct calculations, Mr. Hammer, is it not true that the pressure decline in the Canadian River area is accelerating also?

Mr. March: I object to that question, if the Examiner pleases. Whatever conclusion can be drawn from that, the Examiner can draw it. Counsel not only wants him to go along with the computation but he wants him to make a conclusion, draw a conclusion from those computations and that is additional grounds for objection upon our part.

The Trial Examiner: Objection overruled.

By Mr. Keffer:

Q. It isn't a conclusion in the true sense of the word. You do have accelerated pressure drop, don't you?

A. The figures indicate that.

Q. And plotting that for each year, letting your coordinate points represent each year during that period, it

shows a very decided acceleration in the decline of that pressure?

A. You can take a group of points of that type and it all depends upon the subdivision that you make on your coordinate paper. You can draw any sort of a picture you want to.

Q. You can do that on yours, too, can't you?

A. You can't, no.

Q. All right, now, Mr. Hammer—

A. You only have one factor to consider the way you draw those curves—pressure and years—

Q. Pressure and years are two different factors. I don't see any use of discussing that curve. You have said that it wasn't indicated, haven't you?

A. Those figures you put in indicated it.

Q. Don't you know it is true?

A. I haven't checked those figures.

Q. Don't you know it is true anyway?

A. No, I do not know it isn't true.

Q. Don't you know anything about this after a year and a half work on it?

A. Yes, sir.

Mr. March: I object to the question. This witness has been harangued enough, if the Examiner pleases. A remark like that in the record is not justified and I ask that it be stricken.

Mr. Keffer: I will agree with counsel.

The Trial Examiner: He has agreed to strike it.

By Mr. Keffer:

Q. Now, let me ask you a very simple question. The increase in pressure drop from 1938 to 1939 was almost sixty per cent greater than it was from 1937 to 1938, isn't it?

A. I don't know. I haven't calculated it.

Q. Look at it. Assuming my figures are correct, then, it is about sixty per cent greater.

A. I will say that it is, but it doesn't in my opinion mean anything.

Q. All right, it does mean something if the production did not increase anything like sixty per cent during that period, doesn't it?

A. No, I don't think it does.

Q. Well, why doesn't it? Suppose the production did not increase at all, yet your pressure drop did increase sixty per cent, would that mean anything to you?

A. All right. A curve of that type doesn't mean anything unless you bring into it the volume of gas removed.

Q. That's just what I'm doing, and you won't let me.

A. No, you aren't, you're plotting pressures against time.

Q. But now we are bringing production in, Mr. Hammer. Listen to me. That was the basis of the question that I asked you, the production angle. Now, if you have a decline in one year from 1937 to 1938 of 5.58 pounds and then you have a decline from 1938 to 1939 of 8.09 pounds, and if you had no increase in production, if you have had the same production figure for each year, then would a decline like that mean anything to you? That was my question. You have got the production in it.

A. Well, there are so many factors the way you have put that figure, it would have to be checked. You have made a statement there as far as I see it, Mr. Keffer, that there actually has not been any increase in withdrawals from time to time. I don't—I can't look at a thing like that and check it here on the witness-stand when you are talking about—

Q. Now, listen, Mr. Hammer, and listen to this question carefully and see if you can't get it. Let me repeat it again. We have a production decline from 1937 to 1938 of 5.58 pounds. We have a production decline in the same area from 1938 to 1939 of 8.09 pounds. Now, assuming—

Mr. Spencer: You meant "pressure decline" instead of "production decline"?

Mr. Keffer: Yes, that's right.

Q. Now, assuming that the actual production for each of those periods was the same, would that increase in pressure decline mean anything to you. Now, that's a simple question. See if you can't answer that.

A. If the production remained constant?

Q. If the production remained constant for each year.

A. It would indicate something, yes.

Q. All right, what would it indicate?

A. It would indicate greater withdrawals from—
Q. If the production was constant.
A. You didn't let me finish.
Q. All right.
A. That's just one of the things I've been talking about. Locally around the various areas we took into consideration just the thing that you are talking about there, that there was local gas movement from one area to the other.
Q. And we have included all these areas, remember that.
A. No.
Q. All areas in which Canadian River had a foot of acreage is included.

The Trial Examiner: You are speaking, Mr. Keffer, of this calculation which you have just recently gone through?

Mr. Keffer: Yes, sir, that's right. That was the average weighted pressure and the pressure declines from year to year in the group of quadrants in which Canadian River has acreage.

The Witness: Well, let me say this, that I don't believe that that method that you have used there, Mr. Keffer, is—

By Mr. Keffer:

Q. Mr. Hammer, can't you answer a simple question just once in five days?
A. Yes, if I'd answer them the way you want me to.
Q. Answer it some way. Just answer it.
A. All right, I was going to answer it. What I started to say, that drawing this curve as you have drawn it and using the data as you have figured it out, why, the curve is probably—it probably indicates a drop from year to year there. That is to be expected. You get a drop, but the question of the increment of increase of drop this curve doesn't represent.
Q. Just forget about the curve and go back and answer my question some way. Let's dispose of the question by having an answer to it.

The Trial Examiner: Mr. Hammer, he has gotten away from the curve now. Read the last question, please, Mr. Reporter.

(The question referred to was read by the reporter, as set forth above.)

By Mr. Keffer:

Q. Now, will you please answer that question?

A. Well, assuming that your calculations are correct, it would mean an increase in gas taken out of the ground other than the metered gas that we used.

Q. Would it indicate depletion, an increase in depletion at the same volume of production?

A. I don't figure that way, but if you want to figure it that way, it would.

Q. Answer yes or no. Would it or would it not?

A. I don't think you can figure depletion from one year to another. If you want to figure it that way, yes it would.

Q. Could it possibly mean by any stretch of the imagination, Mr. Hammer, that maybe some of the gas going out of those areas underground is a result of drainage?

A. Well, it could mean part that and it could mean something else. In our case it could mean some of the unaccounted for gas; that is, gas other than metered gas that we didn't take into consideration.

Q. You mean they lost all that in blowing wells?

A. No, I didn't say that. I said some of it.

Q. All right.

A. Now, let me finish my answer. There are some wells that I remember in that territory where they were drilled too deep and unless they have been repaired, those nonproductive sands and gravels down in the granite wash have been acting as thief sands to take some of that gas out. How much, I don't know, and no one else knows, but they are factors to consider.

Q. All right, now, Mr. Hammer, you are reaching out, grasping at straws, aren't you?

A. No, I am not grasping at any straws, I am telling you facts.

Q. Isn't the most plausible explanation, the only one that has any reason back of it at all, that in addition to the gas that is coming out through your well bores you are also losing gas by migration from that area, from that group of quadrants to another which has resulted in a larger pressure drop than the same volume of gas had indicated theretofore?

A. I at no time since I have been on this witness-stand denied that there was some local *draiage*. I don't deny it now.

Q. Well, then, I take it that you have finally answered that in all probability it is caused by drainage, is that correct?

A. A part of it could be. I have explained that there are reasons—

Q. How much of it do you think would be caused by drainage?

A. I have no idea, but the causes are there that could account for it.

Q. Well, do you think that the operators in that field are so extravagant that they waste anything like that much gas in blowing wells, for example, which is not metered?

A. I have no idea of what they do in that field on wasted gas.

Q. Let me ask you another thing: Look at your map over here. Could that not also result, as your lower pressures eat back into the higher pressure areas and you get into high pressure areas that were high the year before but are lean, don't have much gas in them, and where a little gas will drop the pressure more than it did back here in the more productive areas? Now, couldn't that have happened?

A. Read that question. I don't think I understood what you are trying to get at.

(The question referred to was read by the reporter as set forth above.)

The Witness: There are so many angles to that question—you are trying, as I see the question, Mr. Keffer, to bring into that question several factors such as drainage and permeability and what-not.

By Mr. Keffer:

Q. No, just one simple factor, whether or not a given production of gas will result in a higher pressure drop in a lean area than it will in a much more productive area. That is all the element there is to that.

The Trial Examiner: That is your question, now?

Mr. Keffer: Yes, it could be stated that way. Really that would hardly be an intelligent question within itself. You would have to read the two together. It is rather an explanation of my former question.

The Witness: What was that question?

Mr. Keffer: It has been suggested that I restate the question.

Q. That larger pressure drop which we have been discussing which occurred in 1938 and 1939 could have been influenced to some degree by the fact that as pressures eat back further and further and further, that is, lower pressures eat back further and further into a high pressure area and began reducing the pressures in areas in which much gas is not to be found, that that fact within itself would have a tendency to reduce the pressures with the same volume of production, is that not correct? It is somewhat in the nature of a statement. It is hard to state it otherwise.

Mr. March: Assuming, Mr. Keffer, of course, that they were eating back.

Mr. Keffer: Well, his own map shows that.

Mr. March: Well, that is a conclusion on your part.

Mr. Keffer: No, that's his conclusion. He made the map, I didn't.

The Witness: Well, I don't know. I am really honest when I say that I can't figure out how to answer that question because I don't understand it.

Mr. Keffer: Well, just strike the question, then. I'm too tired to take any more time on it.

Q. Now, Mr. Hammer, if you have this accelerated drop on Canadian River's acreage which has increased practically sixty per cent from 1938 to 1939 as compared to 1937 to 1938 and which has been increasing every year over the period, would you or would you not expect that acceleration in decline to continue into the future?

A. I have stated previously I do not know what is going to happen in the future. If present conditions continue to exist as they are now, I wouldn't anticipate that it would

materially increase. I would anticipate that it might decrease. I am not going to predict what is going to happen.

Q. What could happen that would cause it to decrease?

A. Well, they might quit drawing so much gas out of that territory.

Q. I am assuming the same volume of production to make it easy for you to answer.

A. Well, even then, not on one year's history, I wouldn't assume any such thing.

Q. I know, but you have a continuous decline for the entire period that you studied.

A. I'll tell you what I'll do, I'll agree to this maybe, that it is a whole lot closer if you would go back over all of your years and figure out what the increment of increase is rather than to take just one year, why, we might be getting closer together, but to take just one year I wouldn't agree to that at all because it isn't fair.

Q. One year doesn't mean anything, I take it.

A. Not when you have a life history of several more years, no.

Q. All right, does five years mean anything?

A. Yes, it means more.

Q. That's what you took.

A. It means more, that's true.

Q. Yet you have a curve that gets a little more sloping each year, each year during that period.

A. The way you have drawn it, that is true.

Q. And it would be that way if you drew it, wouldn't it?

A. Well, I don't think I would draw a curve like this.

Q. No, you wouldn't. You wouldn't draw the curve as it actually happened. You would draw a straight line across there which shouldn't be a straight line.

A. I would draw a curve, using the data necessary.

The Trial Examiner: I think the record is certainly full of that, Mr. Keffer.

Mr. Keffer: I think it is, too. I wonder if we might take a short recess.

The witness stated that although he had used the word "academic" with respect to his fieldwide estimate, there was nothing academic about it in so far as his estimate was

concerned but it was a real figure, and it was his thought that its relationship to the reserves of the Canadian River Gas Company might be largely academic.

The witness had made some references to a 73-year life for the reserves of Canadian, but the figure was used only in an illustrative manner and it was not his conclusion as to the life of Canadian River's reserves because he didn't know what would come in the future.

He was then asked the following questions:

"Q. What is your definite conclusion?
A. I haven't arrived at any.
Q. You just don't know how long it is going to last?
A. All I have attempted to do in this whole thing is to arrive at a reserve beneath the Canadian River acreage.

The Trial Examiner: As of—

The Witness: As of August 1st, 1939.

Q. Do you mean to say in your testimony that the Canadian River will recover that entire figure which you set out there as its reserve as of that date?
A. That question is a question that isn't a question directly associated with an estimate of reserves.
Q. Oh; I'll grant you that, except this, that you have to consider those angles in making your estimate, don't you?
A. No; not in making an estimate of reserves.
Q. In other words, you didn't try to make an estimate of recoverable gas, but rather the gas that is in place there today?
A. That's right.
Q. Without any conclusion that you might recover that much gas or more than that, or what-not.
A. That's it. This whole reserve study, and a reserve study in any case is to arrive at the gas in place on a given date as near as you can.
Q. Well, then, your figure which you use of 3,645,213,000,000 cubic feet as of August 1, 1939 was not intended as a figure representing recoverable reserves, but rather remaining reserve in the ground as of that date?

A. That's right, remaining reserves down to 25 pounds well head gauge."

The witness had computed his reserves down to an assumed abandonment of 25 pounds gauge pressure at the well head, and for the purpose of illustrating the point, stated that the virgin pressure was 430 pounds and in calculating the remaining reserves to 25 pound abandonment he would simply subtract 25 from 430 and determine how much gas there was in place with 405 pounds pressure.

The witness stated that the 25 pound abandonment pressure utilized by him was not intended to be representative of the actual economic abandonment pressure because he did not know what the economics of the thing would be. It is his opinion that the proper abandonment pressure is an economic question and that it will be solved in the light of economic conditions and situations existing at the time the problem presents itself.

He had made no study of the economic situation that might prevail at that time.

The witness was then examined with respect to the matters mentioned in his original statement which tended, in his opinion, to make his estimate a minimum one. He stated that his estimate represented a minimum figure because the pressures of the wells in most cases were not permitted to build up to a normal pressure, but stated, on the other hand, that if the pressures of 1935, for example, were not entirely stabilized, and if the pressures for subsequent years were not entirely stabilized, then this would make no particular difference, but he didn't know whether the proportion of low pressure was any greater in one year than another. His premise assumed the pressures were O.K. in 1935, but began getting too low after that. The witness stated, however, that it might be true that the errors inherent in the pressures for each year might wash out, but he does not know precisely how the closed in pressures would vary from year to year. For example, if the pressures, as actually gauged, were low in 1935, he couldn't assume they might also be low in the same proportion for 1936, but if this were to be assumed, then the drop would be just the same and his estimate wouldn't be affected. He also stated there would be a tendency for the same

error in taking pressures to occur each year and that it would be fair to assume that some error would occur each year, but he couldn't say how much, but if the same error did occur each year, it would completely wash out, and that the overall pressure differential would be the same.

The witness further testified (Vol. 59, pp. 8447-8465) as follows:

Q. All right, now, let's go on to No. 3. Well, we'll take No 2. You say you haven't considered unmetered gas that was wasted. Do you mean by that, gas used in blowing wells, in wells of that type?

A. Yes, only gas that was metered and reported to the Texas Railroad Commission.

Q. Yes. Now, I can understand very well how that—the fact that you did not consider that might give you a lower production per pound drop in pressure. That is quite true, but on the other side of that thing; if you had considered these sloping lines that we are talking about when you consider production against them, they might have been more slanting than they are, isn't that a fact?

A. No, that is not true.

Q. It isn't?

A. No, not at all.

Q. All right. One further question on that. The fact that you haven't considered it in making your estimates, also if you try to get field life by dividing into those estimates the total production, and you don't count this unmetered gas, that would have a tendency to give you a bigger figure for the life of the field, wouldn't it?

A. You mean if you had this wasted gas in your calculation?

Q. If you left it out of your calculations in the second place just as you did in the first place.

A. Well, now, let's see.

Q. All right, I'll give you a simple illustration on that. Your estimate—oh, we'll say in round figures—well, I don't like to use yours because we may get some confusion in the record—suppose your estimate was a trillion feet and suppose you had a billion feet per year of metered gas. A billion into a trillion goes a thousand times, doesn't it?

A. That's right.

Q. All right, that would give you a life of a thousand years, wouldn't it?

A. That's right.

Q. But if in addition to that billion feet of metered gas there was 250 million unmetered gas which you did not take into account, which if you had added to that metered gas to divide into our reserves would give you a life of, instead of a thousand years, about 800, wouldn't it?

A. No.

Q. Why wouldn't it?

A. Because it wouldn't. The more gas that you take into consideration when you utilize the decline method as against any given set of pressure drops, the greater will be your reserve.

Q. Oh, I understand thoroughly, but I was going to the next point. I was beyond that. When you have your reserves and you want to determine life by dividing into the reserves the annual withdrawals, but you take only the metered withdrawals and not the unmetered withdrawals, then that gives you a bigger figure for life than you would have gotten if you had added the unmetered gas to the metered gas and then divided. Now, that is perfectly obvious.

A. I see what you mean. In other words, you are getting to the point that if you utilized or if you knew all of the gas when you are figuring life—now, mind you, in figuring reserves it is quite a different thing from figuring your life.

Q. I appreciate that, yes.

A. If you knew all of the gas that had not been metered, it would have a tendency to give you a lesser life.

Q. That's right, so that again, figuring from those two angles, one sort of washes out the other, doesn't it?

A. No.

Q. Now, get me straight.

A. Not at all.

Q. I am talking from the standpoint of determination of life in years and not reserves.

A. I have stated a while ago and I will repeat again that in the estimation of a gas reserve of this type I did not take into consideration anything except to determine the amount of gas in place in the ground as of a given date.

[Further Testimony of the WITNESS HAMMER, continued.]

Q. I appreciate that, and that gave you a little lower reserve than you would have gotten if you had taken this other gas into account.

A. That's right.

Q. I understand that perfectly. Now, let's leave that and go over to the point where we are trying to determine life of the field; then, when we divide only metered production into the reserve figure, you would get a longer indicated life than you would get if you divided the metered gas plus unmetered gas into that reserve figure.

A. Yes, that's all right.

Q. Obviously.

A. I will agree with you on that.

Q. That is, from the standpoint—looking at it from the determination of the life of the field, then one certainly would have a tendency to wash out the other, wouldn't it?

A. Well, as I have said, I haven't made a study of the life of the field particularly.

Q. All right, then, we'll go on to the next one. Now, you say that the pressures were not calculated to reservoir conditions, but were well head gauge pressures. Well, I think I understand that, but after all, if you compute down to an abandonment point of 25 pounds well head pressure, why, that is just what it is. You started with a 430-pound well head pressure, didn't you?

A. Yes.

Q. You didn't compute that 430 pounds well head pressure back to reservoir pressure, did you?

A. No, I didn't calculate the reservoir pressure.

Q. And then that one washes out completely, doesn't it, because you started with a well head pressure, so you had to end up with a well head pressure.

A. The point there is, though, that by utilizing this 25 pounds in order to have that 25-pound abandonment pressure at your wells you necessarily have to have a differential pressure in undrilled areas as against where the wells are.

Q. I understand that.

A. Therefore, you do have a larger amount of gas than is indicated, assuming a 25-pound—

Q. That comes under 4. We are talking about No. 3. We haven't got to 4 yet.

A. Oh, I see. Read that question.

(The question referred to was read by the reporter, as set forth above.)

By Mr. Keffer:

Q. Isn't that right?

A. Yes. I started with 1 and ended up with 1, but we must consider that thing when we go on to 4.

Q. Well, I know, but we haven't got to 4 yet. 3 standing alone is not a good reason for a minimum estimate, is it, not a valid reason?

A. It is not particularly pertinent to the thing, anyway.

Q. Well, it just isn't any reason at all, getting right down to brass tacks on the thing.

A. I think I have answered it.

Q. The point is, I want the record to be clear on that. You didn't start with reservoir conditions in your estimate.

A. No.

Q. But you started with 430 pounds well head gauge pressure, as virgin.

A. As virgin, yes.

Q. Yes.

A. That's right.

Q. All right, now, if you had transported that 430-pound well head pressure to a reservoir pressure you would have gotten considerably more than 430 pounds in the reservoir, wouldn't you?

A. Oh, yes.

Q. And then if you would have come back and figured well head pressures in your calculation to get your drop in pressure, you would have a lot bigger drop than what you did have, wouldn't you, if you startted with reservoir pressures and then ended up with well head pressures, you would have a much bigger pressure drop than actually existed, wouldn't you?

A. If I had used reservoir pressures?

Q. Yes, as your starting point and then deducted from that your lower well head pressures taken at a later date, you would have had a much greater pressure differential, wouldn't you?

A. As between original field pressure.

Q. That's right, and the pressure at any given date later.

A. Yes, using well head pressures would give you a greater differential than it would if you used reservoir pressures.

Q. That's right, so as a matter of fact if you had gone back to reservoir conditions as your beginning point you would have had a lot smaller reserve than the one that you did as you calculated it, wouldn't you—very much smaller because you would have a much greater pressure drop?

A. Restate that for me, will you? Read it, please?

(The question referred to was read by the reporter as set forth above.)

The Witness: Well, let's see, we started with reservoir conditions.

By Mr. Keffer:

Q. That's right, and if we would end with reservoir conditions then it would wash out, wouldn't it?

A. That's right.

Q. But if you started with reservoir conditions and end with well head conditions, or pressures, it wouldn't wash out, would it?

A. But if you start with a well head condition of 430—

Q. And end up with a well head condition at whatever it is, 360 or 350 or what have you.

A. The two methods should almost parallel each other.

Q. That is it exactly. That is the whole point I have been trying to make; so reason 3 as to why your reserve estimate is a minimum one just goes completely out the window, doesn't it?

A. Well, we have to tie that in to 4; so let's go into 4 and then I'll answer it.

Q. We haven't come to 4. We'll take No. 5 and come back to 4. You say: "Consideration was given to the deviation from Boyle's law, but was not applied. Its utilization would have given a somewhat higher result."

Now, let me ask you this in connection with that: When you take into consideration deviation from Boyle's law,

must you not also consider your temperature factor and give consideration to that?

A. Yes.

Q. All right, you gave no consideration to temperature, did you, temperature variations from reservoir conditions and well head conditions?

A. Well, I know the difference between temperatures, while it does have a bearing, is so seldom used in a calculation of reserves unless you want to go down and calculate that reserve to reservoir conditions, at the well head that factor is such a variable that you would have to have a recording thermometer on them all the time to tell what they were.

Q. That is precisely correct. All right, but your failure to consider temperature deviations or corrections for temperature washes out your failure in effect to calculate deviation from Boyle's law; now, isn't that correct?

A. I wouldn't want to agree to that statement. I would want to check it if I possibly could. It is my opinion that it does not.

Q. It does not? Say your average pressure in the field in August 1939 was 332 pounds ,approximately,—331, plus—what is the deviation from Boyle's law at 331 pounds?

A. Well, I don't know that I could give you that offhand.

Q. All right, do you know what the difference in temperature would be of reservoir conditions and well head conditions if you adjusted for that?

A. Well, not offhand.

Q. Well, do you know this? Can you answer me this, Mr. Hammer? I am not going to spend much time on it. Can you tell me whether or not engineers and geologists generally consider that in this reservoir that failure to correct for temperature just about offsets failure to consider the deviation from Boyle's law?

A. Well, I wouldn't know what the general opinion is.

Q. Haven't you ever figured that out to find out just what the difference would be?

A. No, I never figured it out.

Q. All right. We'll go ahead. You don't know, then, for sure whether one would offset the other or not?

A. I doubt if they would.

Q. But to approximate it you—

A. I wouldn't even want to say that without—

Q. I thought you liked that word "approximate," and maybe you would use that one all right.

Let's come back to 4. Are you ready for 4?

A. Oh, I've been ready for a long time.

Q. All right, now, I don't understand you on 4 at all.

A. I didn't think you would.

Q. Tell me about it. Maybe we ought to get into the record. You say, giving an added reason in Paragraph 4, that "Utilizing a 25-pound abandonment pressure well head gauge, necessarily means a higher weighted pressure, because there would be no such well head pressure if there were no higher pressure at undrilled points. In other words, to have 25 pounds well head gauge pressures at abandonment, necessarily indicates a pressure differential between the face of the producing formation in the well as against undrilled areas."

I think that explains the thing.

Q. Well, let me ask you some questions, then. Now, you told me a while ago very definitely and very positively that when you figured this 25-pound abandonment pressure, that that represented what was left in the ground at 25 pounds, didn't you?

A. Well head abandonment.

Q. That's right, and you also figured—you took that 25 pounds from 430 and you had 405 pounds left, didn't you, to produce? Now, isn't that right?

A. Well, if you want to figure it back to original reservoir conditions, yes.

Q. All right, now you have produced 405 pounds, haven't you, when you get down to 25 pounds? You just said that.

A. Well, no. The point is that you are dealing here in one case with a well head pressure and there is a reserve left in the producing formation above that.

Q. I understand that. I am going to agree with you on that.

A. All right.

Q. But wait a minute, we aren't quite ready for that yet. Remember you have got a calculated figure here, haven't you?

A. Yes, that's right.

Q. And that figure is calculated down to 25 pounds abandonment on the theory that you have produced 405 pounds, down to that point, isn't it?

A. Yes, but you are overlooking the fact that there is still a lot of gas in that formation above 25 pounds.

Q. We are going to get to that in a minute. From the standpoint of your calculated figure, if you have produced 405 pounds, and that is what your figure is calculated upon, then from the standpoint of calculations, you have a 25-pound pressure straight across from the standpoint of your calculations, as a matter of fact. Now, isn't that true?

A. No.

Q. Now, tell me how on earth you can get any different result than that.

A. We are talking about a reserve in the ground.

Q. I know we are.

A. And in the other case we are talking about an abandonment pressure.

Q. That's right.

A. The two aren't synonymous at all and one is not dependent upon the other.

Q. Let's go over it again, Mr. Hammer. Remember we aren't going down three thousand feet under the ground and actually measuring this gas, are we? We are calculating it, aren't we, from the top of the ground?

A. That's right.

Q. All right. Now, the figures which you have when you assume a 25-pound abandonment, and you have said it a number of times, you calculate your production, your reserves, down to 25 pounds by taking 25 from 430 which was your virgin pressure and assuming, then, if you are going to produce to 25-pound abandonment, that you are going to produce 405 pounds and you make your calculations on that basis. Now, that's right, isn't it?

A. But you have got to consider that you have a lot of gas left in the ground when you get down to 25 pounds.

Q. Well, that reserve left in that, above your 25 pounds, is still a part of your reserve. I will agree with you on that.

Let's take another angle on that. If, then, you are going to leave some of that in there, you aren't going to produce 405 pounds. That would have to follow, wouldn't it?

A. No, it wouldn't have to follow at all.

Q. How on earth are you going to produce 405 pounds out of 430 pounds and have more than 25 pounds left? Now, you tell me that.

A. We are talking about a well head abandonment pressure.

Q. I know we are.

A. All right.

Q. That's the way we have figured always on well head abandonment.

A. I have said before and I repeat again that ~~in~~ order to have that you must have a lot of gas. The whole reservoir away from your wells must necessarily have a pressure above it. How much above it, I don't know and neither do you. All of the gas that is in that reservoir above the 25 pounds is still a part of your reserve.

Q. Surely. Is that all?

A. Yes, that's all there is to the question.

Q. All right, the only difference between you and me— we agree on the facts, Mr. Hammer, entirely so. I agree that for you to have 25 pounds well head pressure you have got to have a higher pressure back from that well, and that is what your argument is based upon, isn't it? I agree with you thoroughly on that.

A. All right.

Q. There isn't any question about that.

A. All right.

Q. The only difference between you and me—

A. You aren't assigning—the only difference between you and me is that you are not allowing or assigning any reserve to that reservoir above 25 pounds.

Q. Yes, I am. There is where you are wrong. We are right together until we get right down to the point of whether we add or whether we subtract. I say we ought to subtract and you say we ought to add. That is the only difference between us.

A. And I am not going to agree with you.

Q. I believe you will. I still don't think you say it. I made a promise a while ago and I am going to live up to it, anyway.

Now, here, let that very true figure represent your reservoir—is that all right, Mr. March?

Now, you are going to produce that. You are going to produce 405 pounds of that, aren't you?

A. No, —now, wait a minute.

Q. Now, wait, don't you change on me, you have said that too many times.

A. Well, I have been referring back to well head, to what you would get at 25-pounds abandonment, well head.

Q. That's right.

A. Now you come along here with a picture illustrating a reservoir, or attempting to illustrate a reservoir, and the condition is not synonymous at all.

Q. Well, now, listen to me, Mr. Hammer. Please don't back up on me this late in the game. You have said two or three times that in your calculated figure the figure which you used in calculating your reserves down to 25-pound abandonment, that you used the figure of 405 pounds that would be produced and made your calculations on that basis. Now, that is a fact, isn't it?

A. Yes.

Q. And you couldn't do it any other way, could you?

A. But—

Q. Now, wait just a minute. Give me this indulgence here. Now, from a calculated standpoint that is what we are talking about. You calculated 405 pounds produced; so from a calculated standpoint you couldn't have more than 25 pounds left because you only started with 430. Now, isn't that just as simple as it can be stated?

A. No, that is not true at all. You are confusing reservoir conditions with well head conditions.

Mr. March: Mr. Keffer, haven't you made a mistake?

Mr. Keffer: No, I haven't.

Mr. March: You have deducted the 25 pounds from 430 instead of the present weighted pressure.

Mr. Keffer: How's that?

Mr. March: You have deducted it from—didn't you do this? Didn't you deduct it from 430 instead of your present weighted pressure?

Mr. Keffer: I didn't deduct from any sort of weighted pressure. I am assuming virgin pressure.

Mr. March: Which the witness has not done for this purpose.

By Mr. Keffer:

Q. Then take your present weighted pressure and deduct 25 pounds from that and tell me what you figured it on. If Mr. March would rather have it that way, we'll do it that way.

Mr. March: Weighted pressure.

Mr. Keffer: Give me that figure.

Mr. March: You are asking the questions. You can find out what it is.

Mr. Keffer: How do you know it is 430, then?

Mr. March: I know it isn't 430.

Mr. Keffer: All right, 333, we'll say, approximately.

Q. We'll say 333 to start with and you are going to produce it down to what?

A. 25 pounds well head pressure.

Q. You are going to produce how much? —let's see 5 from 5 is nothing, 2 from 3 is 1—you are going to produce 310 pounds, aren't you? I used 335. That's all right, that's near enough.

A. You are going to use that pressure?

Q. That's right, and from the standpoint of your calculation you are just going to have 25 pounds in your reservoir from the standpoint of calculations, arithmetic, I am talking. That's what you are going to have.

A. I am talking about reserve.

Q. That is right, from the standpoint of your calculation you are just going to have 25 pounds in your reservoir?

A. I am talking about reserve.

Q. All right. In that reserve you are going to have 25 pounds less?

A. No, that isn't true at all.

Q. All right. I will go ahead.

It is going to hustle me to make this thing good, but I am going to make this stand. If you have 25 pounds left in the reservoir as a calculated figure, yet actually you have

more than that because the pressure is higher between wells than it is at the well head, then the natural result of that it you have got to make some allowance from that and you have to deduct something from your original reserve because you have something there you are never going to produce. It is subtraction and not addition?

A. No.

Q. All right, that is all. I am not going to argue that any longer. It is too obvious.

Witness Hammer further testified on redirect examination, Vol. 60, pp. 8467-8530, inclusive, as follows:

Q. Since you mentioned here Wheeler County, Quadrant 1, I will ask you to turn to your Exhibit 180, Table 1. I believe it was Hartley County 1 you had a particular discussion in regard to.

Now, there was some indication during the cross examination by counsel that you had in this exhibit erroneously added accumulated production to accumulated production to get your figures there, 6,785, for 1939, in Column G, Accumulated Production.

Now—in other words, instead of adding up your production you just added accumulated production to accumulated production to get your erroneous answer here. It ran around something like sixteen million, I think, instead of what you have here. Now, you didn't do that at all, did you, Mr. Hammer?

A. Why, no. That was brought about by the confusion in attempting to get figures together hurriedly. The actual figures used were the figures that are here on Table 1 in Exhibit 180, in Column G, and those are accumulated figures from year to year.

Q. Yes, in order to get that figure you didn't add up your 5,000 and 3,000 and your 7,000—I beg your pardon, your 5 million, your 3 million and your 793,000?

A. No, not at all.

Q. And the exhibit is absolutely correct in that regard?

A. The exhibit is correct in that regard.

Q. The only difficulty in the cross examination, as I understand it, was the fact that you took off of your working papers rather absentmindedly the figures and added them up?

A. That's right. Naturally, I had to do some of that stuff hurriedly and that error was made, but the correct figures used are those figures shown under Hartley, under Column G of Table 1, Exhibit 180.

Q. Now, that was the only direct implication made with regard to that in this exhibit—

Mr. Keffer: If the Examiner please, I don't know what Mr. March is talking about when he says "implications." I think the record is clear that the error was made. I called it to Mr. Hammer's attention. It was just an erroneous calculation, is all it was.

Mr. March: There was quite a point made of it at the time that the exhibit was wrong.

Mr. Keffer: Don't pick out implications where there were none.

Mr. March: If none was intended, I will assume there were none.

Q. All of this came up over a question as to why you left Wheeler County out down here, Quadrant 1. Then the controversy came up in regard to that in an attempt to show that the production in Wheeler County 1 was higher than Hartley County quadrant here (indicating), and therefore, in the same line of reasoning you should have left out your Hartley County quadrant. That is my understanding as to why this arose. Is that your understanding?

A. It is difficult for me to say what was had in mind. The idea I got was that I had deliberately left that out for an ulterior reason.

Q. Yes. That was your impression, and it was my impression, too, that the reason you left out your Wheeler County 1 was that in order to leave out Wheeler County 1 it would necessarily in doing that increase your estimate of reserve?

A. That was the implication as I got it.

Q. And a great deal of argument as I recall followed and you said that was not true?

A. That's right.

Mr. Spencer: May I interrupt you just a moment, Mr. March?

Mr. March: Yes.

Mr. Spencer: Only for the purpose of suggesting this, that the illustrative quadrants used were for the purpose of analyzing Wheeler County Quadrant No. 1 were Gray County Quadrants 1 and 2, and not Hartley.

Mr. March: I am coming to Gray 1 and 2 in a minute. Hartley was mentioned in that connection, too. The record will so show.

Q. Now, I believe that you stated as your principal reason for leaving out Wheeler County 1 was because you didn't have the production data on that county accurately and reliably.

A. I think it was because of inadequate production data.

Q. You went ahead and gave other reasons but that was the principal reason?

A. That was largely and principally reason for leaving out Wheeler County, that is true.

Q. You recall the other night going over your working papers with me and we noted a very significant thing on those working papers. Will you turn to Wheeler County 1? Now, have your turned to Wheeler County 1 in your working sheets here?

A. That's right.

Q. Now, I will ask you if that is your handwriting on that work sheet?

A. It is not.

Q. That is one of your assistant's handwriting?

A. That's right.

Q. Now, I will ask you what is the notation above—below the compilation on that work sheet?

A. The notation says: "Insufficient production data," and down in the corner, "Not used."

Mr. Spencer: Hadn't we ought to identify that?

Mr. March: I am going to.

Mr. Spencer: You should do that before reading it in.

Mr. March: The witness is identifying it first, and then I will identify it.

Mr. Examiner, I would like to have identified for the record the work sheet, Wheeler County 1—Wheeler Quadrant 1, as Exhibit No.—

The Trial Examiner: Do you wish to have it marked as an exhibit, Mr. March?

Mr. March: Yes. The reason I do that is because any court of law would recognize that a notation made in the course of business in the compilation of an exhibit would be the best evidence of the intentions involved.

The Trial Examiner: It will be marked for identification as Exhibit 191.

(Exhibit 191, Witness Hammer, marked for identification.)

Mr. March: I will have to secure copies of this.

The Trial Examiner: What would you title that sheet, Mr. March?

Mr. March: I would entitle it "Work Sheet, Wheeler Quadrant 1, Texas Panhandle Field."

Q. It was brought out in the record here and I believe you agreed in the record here that by using Wheeler County 1—by not using Wheeler Quadrant 1 you increased your estimate of reserves?

A. It showed an increase above that which would have been if I had used Quadrant 1.

Q. A slight increase as compared with the total?

A. That's right.

Mr. Spencer: Excuse me, Mr. March, you didn't understand me before. If you are going to have it identified and if it is going in the record, why not identify the assistant that made the notation at this time?

Mr. March: This witness' assistants that made these notations are in Washington. They are nothing more or less than Mr. Hammer's assistants and a man when he prepares an exhibit has a right to have assistants working under his direction. Every exhibit which the companies have offered here—Mr. Rhodes' exhibit—none of those working papers are in his handwriting. This man had these working papers made in Washington under his supervision. He couldn't make every notation on there.

Mr. Spencer: Granted. All I am asking you is the name of the assistant that made the notation.

Mr. March: Well, I'll give you that.

Mr. Spencer: I want it in the record. That's what I said five minutes ago.

Mr. March: Before I do that—I don't want to be diverted on this point here:

Q. As I said, Mr. Hammer, as you recall, we agreed that by excluding Wheeler Quadrant 1 you slightly increased your estimate of reserves by the pressure decline method?

A. That's true.

Q. Now, there was a great deal of argument that the production in Gray Counties 1 and 2 was slightly less than Wheeler County 1, and then why didn't you take out Wheeler Counties—Gray Counties 1 and 2? Well, now, if you had eliminated Gray County Quadrants 1 and 2, would not that have likewise increased your estimate of reserves?

A. Yes, it would have, on the same principle.

Q. On the same principle?

A. That's right.

Q. And if you had eliminated Hartley quadrant over here it would likewise have increased your estimate of reserves?

A. That's right, for the area considered. In each case, for the area considered.

Q. And you felt that you had here in Wheeler County a unique situation in the entire field, Wheeler County, Quadrant 1?

A. Yes, it seems that way to me, that's right.

Q. And in your best judgment it could very well be left out in your estimate of reserves?

A. It was a matter of judgment and I felt that way about it.

Q. In other words, that illustrates the point that when you spread this estimate of reserves out over some of these not so productive acreages it has the general effect of decreasing your estimate of reserves, if anything?

A. That's right, because you have taken more acres into consideration.

Q. That's right. In any case, the thing is weighted out, so that when you weight your really productive acreage in with your less productive acreage, the whole thing weights

itself out and gives a fair estimate of the reserves for the entire area?

A. That's right.

Q. Now, Mr. Hammer, there has been some indication here during your cross examination here that you have been coached here from the sidelines. Was this exhibit prepared by you and under your direct supervision?

A. Absolutely.

Q. And the persons working under your supervision were all of lower grade than yourself?

A. Well, that term—

Q. In the classified service of the Federal Power Commission?

A. That's right.

Q. And will you indicate the individuals as near as possible from your recollection who assisted you in this project?

A. Well, do you want me to name all of them?

Q. All of them you can remember, yes.

A. There were A. R. Algier, an associate engineer; Fred Grote—I don't remember his rating—

Q. You don't have to give the titles.

A. Jack Dougherty; Charles Pettingall, and in the compilation of data up to the time when we started the actual estimate of reserves, Mr. H. F. Stevens helped us assemble and get the data together. That's all I can remember.

The Trial Examiner: The same Mr. Stevens that has heretofore testified in this proceeding?

The Witness: That's right. That is all I recall at the moment.

By Mr. March:

Q. Mr. Stevens was an associate of yours in general in this work?

A. In general, that is right.

Q. He is the only person in this hearing room that had anything whatsoever either direct or indirectly to do with this job?

A. That's right.

Q. Besides yourself?

A. That's right.

Q. And when it came right down to making decisions as to how this thing was to be put up, the method employed

and the way it was employed and those decisions, those were made by you?

A. They were my decisions entirely.

Mr. Spencer: Are you all through with the assistants, now, Mr. March?

Mr. March: I am getting to this thing that you wanted.

Mr. Spencer: All right.

Mr. March: I don't want to rush things here.

Mr. Spencer: The only reason I am interjecting is, if the questions and answers with reference to notations on that sheet of working paper relating to Wheeler County, Quadrant No. 1, is not connected with the party that made it, so we can cross examine him, I want to move at the proper time here to strike both questions and answers. That is why I kept interrupting.

Mr. March: You can make your motion at the proper time and we can argue it then.

Mr. Spencer: It was probably proper right after it was done, only I am just waiting.

By Mr. March:

Q. Do you know whose handwriting that is, Mr. Hammer, in the exhibit which has been marked for identification as Exhibit No. 191?

A. To the best of my memory and because it has the initials up here in the corner "C.E.P.," I believe that it is Charles Pettingall's handwriting.

Mr. Spencer: I didn't get that name, Mr. Hammer.

The Witness: Pettingall.

Mr. March: Does that meet with your approval, Mr. Spencer?

Mr. Spencer: Yes. I would like to know what position he occupies or did occupy when he made the notation.

The Witness: I don't recall what his classification is.

By Mr. March:

Q. He was working, though, under your supervision?

A. That's right.

Q. And you did not use Wheeler County Quadrant 1 in your estimate of reserves?

A. That's right.

Q. It was not used in connection with this Exhibit 180 and 179?

A. Well, that is true as far as Exhibit 180 is concerned. In the preparation of 179, why, naturally we isobarred the area. That was the first job, but in 180 we didn't use it.

Q. And you didn't use it in your estimate of reserves?

A. That's true.

Q. You left it out?

A. That is right.

Q. Now, Mr. Hammer, there was quite a bit of discussion here about some cylinder diagrams that had been marked for identification as Exhibit 189. Will you turn to that sheet, prepared by Mr. Hughes?

Now, say we withdraw, as Mr. Keffer had you do, 15,000 from Container No. A, and make your computation as it should be made from there, as you think it should be made, and explain them.

A. This is the problem where you withdraw gas from Cylinder A only?

Mr. Spencer: Which exhibit would that be tied into, Mr. Hammer?

Mr. Lange: 189.

The Witness: That is right. That is the problem that you asked about where you draw from one cylinder only?

By Mr. March:

Q. Yes, sir. I want you to compute your original reserves.

A. Well, if you take the three cylinders, Cylinder A having 30,000 cubic feet; Cylinder B, 20,000, and Cylinder C, 10,000 cubic feet, and you withdraw 15,000 cubic feet out of Cylinder A, you would reduce the pressure from 400 pounds to 200 pounds. Then in order to calculate that back and take into consideration all three cylinders it would be necessary to weight the pressures against the volumes, having in mind that Cylinder A after the withdrawals still

contains 30,000 cubic feet, but at a reduced pressure. You would weight the problem as follows:

30,000 cubic feet times 200 pounds remaining pressure would give 6,000 Mcf. 20,000 cubic feet at 400 pounds pressure would give 8,000 Mcf., and 10,000 cubic feet of gas at 400 pounds pressure would give 4,000 Mcf., or a total of 18,000 Mcf. Then if you calculate that 18,000 Mcf., if you take that and divide it by the 60,000 feet of total gas, you will get a weighted average pressure of 300 pounds. You must bear in mind that the total volume has been reduced from 60,000 cubic feet to 45,000 cubic feet, or 15 over 60, or 15 divided by 60, is one-fourth; also, that the pressure has been reduced from 400 pounds to 300 pounds or 100 divided by 400, or one-fourth. Therefore, the proportion of gas taken out is equal to the proportion of gas—the proportion of pressure taken out, which is equivalent and proves Boyle's law, and, furthermore,—or on a pound loss basis, if you will divide 15,000 cubic feet by 100 pounds loss you will get 150 cubic feet per pound in decline. Then if you will multiply that 150 cubic feet by the pounds in decline you will get 60,000 cubic feet, or the original gas in all three containers.

Q. That is assuming that they are all three inter-connected?

A. That is right.

Q. But that would not satisfy Mr. Keffer. He has another hurdle for you to jump here. That is this: As a matter of fact, that works out, as I understand it—I want to get it straight here first. What you have done is to weight pressures both as to area and content?

A. That's right.

Q. And when you do that you get the right answer?

A. That's right.

Q. But Mr. Keffer would say that the Panhandle field is—you don't have an equilibrium pressure there and these three containers here—and your inter-connected three containers and your pressures are allowed to equalize and you don't have in the Panhandle field—you do not have strictly from Boyle's law standpoint an equilibrium pressure, do you?

A. Not entirely so, no.

Q. In other words, if you secured an equilibrium pressure in the Panhandle field you would have to shut the whole field down for an indefinite period of time?

A. That's right.

Q. And let the pressure equalize?

A. That's right.

Q. And that is both impossible and impractical?

A. Well, under existing conditions that would never be done.

Q. Yes, so you had used the figure which was equivalent to the equilibrium pressure and which will give you substantially the same result, did you not?

A. I used the figure that was the closest approach possible to arrive at the equilibrium pressure, in my opinion.

Q. And what was that?

A. That was the preparation of these maps on isobars of ten-pound intervals and if we had been able to take them on down to five-pound or even on down to one pound, we would have very closely or more closely approached an equilibrium pressure.

Q. In other words, you had the weighted average pressure, as I understand it?

A. That's right.

Q. And the way you have applied that and weighted the whole thing out over your area here, although it is not a perfect answer, it is your opinion that it gives you an answer that for all practical purposes is the correct answer?

A. That is right.

Q. Since you mentioned these 10-pound isobars that you used, will you explain the advantages of using a 10-pound isobar over a 50-pound isobar or a 20-pound isobar?

A. Well, that's just what I had in mind a moment ago. The smaller pound interval you use the more closely you can approach the proper answer. Now, if you took and used 20-pound isobars there are local and sometimes relatively large areas of pressure between that, where you draw a 10 and 20, which would indicate on your ten but which would not show up or be indicated at all if you used 20 or larger.

Q. In other words, when you go down on your isobars to smaller intervals you get a more correct answer?

A. You get a better picture of the areal distribution of pressure.

Q. As a matter of fact, in this exhibit here, by using 10-pound isobars you go further as far as you know in this refinement than anyone else that you know of?

A. I think I have gone farther. I don't know of anyone else that has ever used 10-pound isobar intervals.

Q. What does the Railroad Commission use?

A. I think ordinarily they have used 50 pounds.

Q. Now, since we are on this isobar business, this 10-pound interval, you will recall that Mr. Keffer went at great lengths here to recite to you these pressures beginning at 200 pounds and going up to 400 pounds, at 10-pound intervals. He went over a whole list there. For example, he said from 200 to 210 and from 210 to 220 and right on up the line, and he attempted to show, as you will recall, that 400-pound pressures had just about twice as much weight as the 200-pound pressures.

A. Yes, I recall that.

Q. Assuming all the pressures there in one isobar. Now, as a matter of fact, Mr. Hammer, is this statement not true? If it is not true I want you to tell me.

Mr. Keffer: Just ask the witness a question.

Mr. March: I will ask the witness the questions as I see fit, unless the Examiner rules otherwise.

Mr. Keffer: Mr. Examiner, Mr. March has no right to lead the witness.

Mr. March: I don't have to lead the witness. There is no rule of evidence in the court that I can't lead the witness to a certain extent on redirect.

The Trial Eaminer: He is your own witness, Mr. March. However, I will say—

Mr. March: Well, go ahead, make your ruling.

The Trial Examiner: May I rule now?

Mr. March: Yes.

The Trial Examiner: Let me say this, that so far as your leading questions are concerned, the witness is a responsible witness and I don't feel that it is harmful, and

perhaps it will expedite the hearing, and I am sure that Mr. Hammer appreciates the obligation of his oath.

However, I think, Mr. March, that you should bear that in mind and when it is at all possible to let the witness give the facts in the case, and I think you should proceed on that basis. I am not going—

Mr. March: Mr. Examiner, thus far this has been the only question that has been objected to, and it doesn't make any difference how strict the rules are applied in regard to us, we will not lead the witness directly or indirectly in this regard if the Examiner feels that way about it.

The Trial Examiner: I haven't said you could not lead the witness, Mr. March.

By Mr. March:

Q. What have you got to say about that, Mr. Hammer?
A. About that question of 200 and 400 pounds?
Q. That's right.
A. I think the best way to illustrate and define that situation is to state that in any case a segment having 400 pounds pressure considered in that light alone would contribute twice as much to the total factors as would the 200 pounds, but that each of the segments contribute equally to the average and that would hold true of any *infinitecimal* amount of segments.
Q. In other words, it would be likened to a scale, when balanced out it would level itself off?
A. That's right.
Q. Mr. Hammer, there has been some question raised as to whether or not the method which you employed here in estimating reserves has ever been employed before.
A. That question was asked me.
Q. Yes. You recall first that there was a great deal of questioning, though, in regard to the porosity pay thickness method of estimating reserves and you recall that the first question was asked you as to whether or not you recalled an estimate made by C. Max Bauer.
A. C. Max Bauer.
Q. Around 1931 and 1932, I forget which it was and you said you did, did you not?

Mr. Keffer: Just a moment, Mr. March. Mr. Hammer volunteered the statement about Max Bauer.

Mr. March: You asked him first as to whether or not he knew of any estimates being made by the porosity thickness method in the early days and he answered the question.

Mr. Keffer: He said he understood that Max Bauer made one.

Mr. March: You asked the question and he answered it.

Mr. Keffer: Just a moment, that question was based upon the early porosity thickness method, or was it an estimate?

Mr. March: You can have a chance with the witness on recross. You can ask him about that on recross examination.

Mr. Keffer: I think it was on an early field estimate, regardless of the manner employed to make the estimate. That is rather my definite recollection of it. I could be wrong about it.

Mr. March: The record will speak for itself in that regard.

Q. You do recall a discussion about it?

A. Yes.

Q. You do recall quite a number of questions as to the soundness of the porosity sand thickness method in estimating reserves?

A. That's right.

Q. And I believe your opinion was that in regard to that—

A. That as far as the Texas Panhandle field is concerned it would give an erroneous answer and it really was not applicable in my opinion to an estimation of reserves in that field.

Q. Because you couldn't get adequate cores?

A. Because you couldn't determine the porosity adequately.

Q. You recall thereafter the question was asked you as to any estimate of reserves which had been made previously in which your method was employed or any portion of your method was employed?

Mr. Keffer: I never asked any such question as that.

Mr. March: I suspected Mr. Keffer would raise up and object to this, so I just got the record out here.

Mr. Keffer: All right.

Mr. March: So I want to read exactly what happened.

Mr. Keffer: You read just exactly what happened.

Mr. March: I will read the record on Page 7950. First I will begin reading on Page 7949;

"By Mr. Keffer:

"Q. Mr. Hammer, we were discussing yesterday the matter of quadrants and the way in which you have utilized them. I will ask this in that connection, if your approach to this problem in the application of the pressure decline method has been the orthodox approach to a problem of this character by utilization of that method."

Mr. Keffer: That's right. I asked that question. That isn't the one you asked.

Mr. March: Mr. Keffer, I've got the floor here and you will have the witness on recross.

Mr. Keffer: You state it the way I asked him the question and there will be no objection from me.

Mr. March: "A. Well, it has been used by others in similar proceedings.

"Q. You mean the dividing of a field such as this into quadrants?

"A. Into areas. They didn't call them quadrants, but it has been done."

Q. Now let's take the next question that Mr. Keffer asked:

"Q. Where has it been done?

"A. That has been done in the case of the recent estimate by the Phillips Petroleum engineers and geologists."

Then Mr. Keffer asked the question:

"Q. They didn't divide them into quadrants like you did, did they?

"A. Areas.
"Q. Didn't they follow contour lines pretty well?
"A. In certain instances but not in all instances.
"Q. And you haven't followed them at all?
"A. No."

Then the cross examination in regard to that continues on.

The Trial Examiner: Now what is your question?

Mr. March: I am just getting to it.

Q. You recall that, do you not, Mr. Hammer?
A. Yes, I recall it.
Q. Did the Phillips Petroleum Company use a similar method to yours in estimating the reserves of the Panhandle field?
A. They did, very similar.
Q. And just approximately how did their estimate of reserves compare with yours?

Mr. Keffer: Just a moment, just a moment. If they want to prove the Phillips Petroleum Company's estimate, let them have the man that made the estimate come in here and withstand cross examination. You can't prove a reserve estimate by any such indirect method as that.

Mr. March: We aren't attempting to put on an estimate of reserves of Phillips Petroleum Company. We are attempting to show that the method employed by Mr. Hammer was a well-established method, that it had been used previously, been tried, and that the results were not unlike his. I haven't asked him for the specific estimate of the reserves.

The Trial Examiner: You are objecting to the question, Mr. Keffer:

Mr. Keffer: Yes, I am.

The Trial Examiner: The objection will be sustained.

By Mr. March:

Q. Do you recall as to whether or not Phillips Petroleum Company in its estimate of reserves attempted to employ the porosity thickness method?

A. They did not.

Mr. Keffer: Now, if Your Honor please, even on that, that is a pretty broad question. Mr. Hammer may know and he may not, I don't know, but certainly whether or not they attempted to use the porosity thickness method, the man that did the estimating is the one to answer that. It is wholly hearsay.

Mr. March: This quesion is entirely different—

The Trial Examiner: Mr. March, the witness has answered the question. It can do no harm in the record.

Mr. Keffer: As it stands now, I don't see as it would, really. It is rank hearsay and hearsay testimony I believe proves nothing. I think the courts have held that, and with that thought in mind, it makes no difference, if the Examiner agrees with me.

By Mr. March:

Q. Mr. Hammer, do you know whether or not the Phillips Petroleum Company have substantial acreage in the Panhandle field or not, of your own knowledge?

Mr. Keffer: If the Examiner please, just there, again, this is going far into the night, probably, on this line of—

Mr. March: I have only a few questions here I am going to ask on this.

Mr. Keffer: Whether the Phillips Petroleum Company has much acreage or little acreage could have no possible effect on an estimate of reserves made by them or anyone else. That doesn't affect the reserves to the slightest extent and I, therefore, object to that question as wholly irrelevant, incompetent and immaterial.

The Trial Examiner: Well, if the witness knows—the witness has gone over the field—he may answer.

The Witness: Well, I did have occasion, Mr. Examiner, to check roughly the acreage that the Phillips Petroleum Company have in the Texas Panhandle field in connection with the application of the Independent Natural Gas Company that was made to the Federal Power Commission. At that time I was requested to check the acreage that they

held in the Texas Panhandle field. I don't recall offhand the figure at which I arrived, but I do know that they have a very large and substantial acreage in the Texas Panhandle field.

By Mr. March:

Q. Mr. Hammer, I am going to read you a quotation and I am going to ask you if you agree with it. If you don't agree with it you can say you don't agree with it. This quotation is one I will read to you. It is contained in the physical transcript of the record in the matter of Independent Natural Gas Company, Docket No. G-178, Federal Power Commission, Page 305 and 306, and I just want to know whether or not you agree with that portion of the testimony of Mr. C. E. Turner. Do you know who Mr. C. E. Turner is?

A. I know he is an engineer with the Phillips Petroleum Company.

Mr. Spencer: Now, Mr. March, before we start reading into the record—

Mr. March: We can always strike. If the Examiner rules, it will be stricken. I have a right to ask the witness whether he agrees with a certain statement or not.

Mr. Spencer: We are getting right down to the thing the Examiner ruled on.

Mr. March: It is not getting to the estimate of reserves at all. I am just reading from this authority here and asking him if he agrees with the authority. That's all I'm doing.

Mr. Spencer: Well, I think very early in these proceedings we had a discussion about reports made by experts and as I recall you objected, that you did not have any opportunity to cross examine the expert and the Examiner agreed with you.

Mr. March: That's right.

Mr. Spencer: Now, we do not want you to read anything into the record from any expert on this subject that we cannot cross examine.

Mr. March: There has been read into the record here and prepared in exhibit form even quotations from tax reports in regard to technical matters. This porosity thickness method is a technical matter, and anybody can read from the sworn statement of an expert and ask a witness on the stand whether he agrees with him or not. I am not putting in evidence here the testimony of a witness here which is not permitted to be cross examined. I am merely asking him whether he agrees with this expert or not.

The Trial Examiner: Let's get this straight, Mr. March: You are trying to put into the record in a backhanded manner testimony of some other witness before the Federal Power Commission. Now, the Examiner is not going to permit it and there is no use of taking up time on matters of that nature.

Mr. March: The Examiner can say so and that is all there is to it. However, it was not with the intention of putting in evidence in a backhanded manner. Commission's counsel accedes to that because it was merely an attempt to here quote from an expert just like I would quote from a text book. I can quote from text books here by any individual as to the definition of permeability and porosity, can I not? I want to know because I may want to take a quotation from a text book and ask him if he agrees with that definition.

Mr. Spencer: A recognized text book is a whole lot different than reading out of another proceeding before the Federal Power Commission. The testimony is for one purpose and the text book is for another.

By Mr. March:

Q. Mr. Hammer, on yesterday we went over in the record—Mr. Keffer went over in the record a long series of reasons you have—five reasons you have on Page 15 of your written statement as to why this reserve figure that you have up here is a minimum estimate of reserves. Will you get your written statement out so we can go over those points at this time? Have you got those out, Mr. Hammer?

A. I have.

Q. Now, I believe the first reason here that you gave as

the reason for this minimum estimate of reserves is (1) "Stabilization of pressures are seldom if ever reached during the 'closed-in' period prior to determination."

A. That is the first one.

Q. Will you explain it just exactly for the Examiner—simply show everybody here just exactly what you meant by that.

A. Well, I meant, as I stated yesterday, that closed-in pressures in a field are seldom if ever obtained up to the maximum that might be delivered. I mean the maximum pressure that might be obtained at the well head when all other wells are producing gas or in the immediate vicinity of the wells where the pressure is being taken, and the location of the wells. There are all sorts of variabilities in the permeability fa or.

Pressures might build up rapidly in one area and take a longer time to build up in another area because of the permeability factor. Under conditions of that type the wells never are on the average allowed to remain closed sufficiently long to get a real stabilized pressure. Now, if you take the question as it was discussed yesterday as to the fact that the isobars which we used based on closed-in well head pressures and as to whether the curves that we projected were based on minimum pressures, that is true, but that is just the point I want to make and I thought I had made it yesterday.

If your isobars are low and if a pressure decline curve is low, the facts are that if you had the better pressures, then they would be—your curves and your isobars would be drawn on that higher pressure. Now, you project a curve—

Q. You so projected a curve for illustrative purposes here?

A. I have projected a curve for illustrative purposes, yes.

Q. Let's describe your curve that you have drawn.

Mr. Keffer: Let him finish his statement.

Mr. March: I object to the interruption by opposing counsel. I want to ask the witness to illustrate this curve here. I have asked him whether he drew the curve or not.

Mr. Keffer: You broke in in the middle of the witness' answer of the other question.

The Trial Examiner: Had you completed your statement, Mr. Hammer?

The Witness: Well, will you go back and see when I quit?

(The record referred to was read by the reporter as set forth above.)

The Witness: I will make just one more short sentence to finish that statement: You project a curve on the higher pressures and its intersection will hit farther out, always, on your volume ordinant.

By Mr. March:

Q. Now, as I understand this, Mr. Hammer, in regard to your first reason here you have, we'll say right here in the middle of this piece of paper a well, and you have formations all out around that well. You tell me whether I am right or not—formations all out around the well. You have gas in that formation.

A. That's right.

Q. As I understand it, when you gauge these pressures you don't shut the well in and let the field equalize. You don't have an equilibrium pressure?

A. Not a true equilibrium pressure.

Q. That's right. As I understand it here—

Mr. Keffer: If Your Honor please, I don't know what he is leading to. I don't think it makes a lot of difference, but I want to call the Examiner's attention and Mr. March's attention to the fact that he is making a statement and putting the answer in the witness' mouth. So far it doesn't hurt.

The Trial Examiner: Go ahead, Mr. March.

By Mr. March:

Q. As I understand it, in view of the fact as you have stated here that you don't shut in the wells and let the pressures all equalize, that the pressures in these surrounding formations are always higher than the pressures are at the bottom of the hole.

A. In general I think that is true.

Q. And so even if you take your measurements by dead weight measurements, which is actually absolutely accurate, assuming that, the measurement of the gas pressures at the bottom of the hole here would be lower than in this surrounding—in these surrounding formations, is that right?

A. Yes, if your pressures had not reached stabilization, that would be true.

Q. And they haven't reached stabilization in the Panhandle field to your knowledge, have they?

A. I am speaking now about where you take pressures locally in a given area of two or three miles around a well. In discussing the thing with engineers of the Texas Railroad Commission I got the impression that they did not close wells down over great areas in order to take their closed-in pressures, and if they didn't close in considerable areas all at one time, their closed-in pressures as taken would be a minimum.

Q. And the pressures here at the bottom of the hole would be naturally, since they weren't allowed to equalize and come up in the hole, would be lower than in the surrounding formations?

A. That would be true.

Q. In other words, as I understand it, in every case that is the reason you stated that in practically every case you would get a minimum pressure?

A. That is I think true.

Q. Now let's go to this diagram which you say you have drawn here which illustrates that very well, as to the results as I understand it, and you may explain that as to what type of diagram you have here and what it illustrates.

A. Well, it is simply illustrative. I have just projected two lines, one representing a curve drawn on the pressures, say, that we took, and one drawn at a pressure somewhat higher, the lower one representing the pressures as we realized them and the upper one representing the pressures that would approach more closely to stabilization. In other words, the higher pressures.

Now, if you project a curve, using the somewhat lower pressures, it will hit at a less distance from the zero point

on the volume ordinant than it will if you utilize the higher pressures that would exist. In other words, your point using the higher pressures would hit the volume ordinant at a greater distance from zero, giving you in volume a larger reserve.

Q. In other words, you have drawn a diagram there which, as I understand it, and see if I understand you correctly, on which you have your pressures and production applied against your pressures.

A. Diagrammatically, yes.

Q. Diagrammatically, and roughly for illustrative purposes?

A. That's right.

Q. And then you have that diagram there and you extend a line diagonally down across this paper making a rectangle. The line which you extend down is illustrative of the pressures actually taken at the lower levels?

A. That is right.

Q. In other words, the pressure taken without shutting in the whole field or the whole surrounding territory and allowing them to equalize which would naturally, as you state, be a lower pressure?

A. A lower pressure, that's right.

Q. Now, if the field had been shut in or if the pressures had been allowed to equalize, as I understand it, you state that the pressure at the bottom of the hole in the well would have been higher, therefore, you would draw another line to illustrate these entire pressures?

A. The pressures at the well head or the bottom of the hole, each one would have been higher.

Q. That's right.

A. The point is that with those higher pressures plotted against whatever accumulated production you would have, you would get a greater distance projected out on the volume ordinant of your coordinate paper, thus on pressures alone giving you a greater reserve.

Q. And so that is the reason why, as you have stated here in your point 1 that this is a minimum estimate of reserves?

A. That would be one of the reasons.

The Trial Examiner: We will stand in recess for five minutes.

(At this point a short recess was taken, after which proceedings were resumed as follows:)

The Trial Examiner: The hearing will be in order.

By Mr. March:

Q. Mr. Hammer, in my question a few minutes ago I spoke of the bottom hole pressure. What I meant I think was—tell me whether I am right or not—well head gauge pressure.

A. That is what I used throughout, well head gauge pressure.

Q. That is the correct terminology?

A. That is right.

Q. I was mistaken on the bottom hole. Now, Mr. Hammer, your second reason here as to why this is a minimum estimate of reserves, Page 15 of your written statement, as I read it is as follows:

"During the period used for determination of reserves, only metered gas was employed. No estimate of wasted gas was made."

Now, will you explain what you mean by that in your own words.

A. Well, just exactly what the thing itself states, that we did not take into consideration anything except metered gas. Now, anyone who has studied the Panhandle field knows that there was an enormous wastage of gas beginning probably in its worst state—oh, between the years of 1926 and 1929, and that it became so bad that the Texas Railroad Commission felt justified in doing something about it and in 1935 they took steps to try to prevent that sort of wastage.

Now, as I understand it, while the orders promulgated by the Texas Railroad Commission, were effective as of August 1, 1935, that actually the wastage continued throughout, but maybe with somewhat less degree, throughout the remainder of 1935 and well into 1936 and it took some time after that before the wastage was eliminated. In fact, even as late as 1939 there was considerable gas reported as gas that was not metered, by the Texas Railroad Commission.

The point I am trying to make is that even after, or during the period from 1935 to 1939, there was a considerable amount of gas which no metered record existed, but the only thing we took was the metered record, and any amount of gas coming out of the ground unmetered, if we had utilized that gas in our estimate of reserves we would have undoubtedly had a larger estimate that we have submitted.

Q. Have you prepared a diagram similar to the diagram that you had a few moments ago which illustrates generally and roughly just exactly why this is an estimate in that respect because of that reason?

A. Yes, I have.

Q. Will you describe it and discuss it here?

A. Well, I have drawn an illustrative curve showing that although—if it had been possible for us to get the more accurate pressure and would have projected that through with some more accurate pressures, yet if we did not have the total gas withdrawn, that the accumulated points on the volume ordinant in the projection of a curve at the same pressures would have extended further out on the ordinant from zero and when projected through would have given you a very much larger estimate of reserves.

Q. Now, let's see if I understand this: Here you have drawn a rectangle, as I understand it—

A. No, it is a triangle.

Q. I mean a triangle, with pressures on the left-hand side and your volume at the base of the triangle.

A. One is the pressure ordinant and the other is the volume ordinant.

Q. This line runs across intersecting the two ordinants. The first line here represents roughly the production figure that you did use, just for illustrative purposes.

A. That represents—that line represents an accumulated production against a pressure decline.

Q. Was that the recorded production?

A. The lower one would represent the recorded production.

Q. And the higher one represent the—

A. Would represent roughly the condition that would exist if you had taken into consideration all unmetered gas.

Q. In other words, as I understand you to say there

that there has been considerable gas produced since 1935 which has gone unmetered, there is no record of it.

A. I think that is a true statement.

Q. Some of it has been blown into the air and *other* disposed of without any reliable data as to the accurate amount.

A. That's right.

Q. And it is simply your contention here that this is a minimum estimate of reserves because if you had had those figures, the complete figures as to all the gas which had been produced, your estimate of reserves would have been higher?

A. That's right.

Q. Now, is it your position, though, that since 1935 there has been such reliable data as to production that you are enabled, taking the five-year period, to make an accurate estimate of reserves by the pressure decline method?

A. As I see it, we made an estimate based on metered gas only which in my opinion gives us a minimum estimate.

Q. However, Mr. Hammer, what if you had—oh, yes, I believe you testified on cross examination that you did not take the period beginning 1928 and extended to 1939 because of the unreliable information back of 1935, is that right?

A. That is right.

Q. That is still your opinion?

A. That is still my opinion.

Q. And you have made some effort to ascertain whether or not you can get reliable data prior to 1935?

A. I think I have made as much of an effort as anybody could.

Q. And would you yourself as a geologist and engineer want to rely upon an estimate of reserves by the pressure decline method taking the entire production of the wells—

A. From the beginning?

Q. Yes, with the data that is available.

A. No, I would not. That is the reason I didn't use it.

Q. Well, then, Mr. Hammer, I want to dispose of the other three. You have three other reasons here, three more, as to why you consider this a minimum estimate of reserves.

Now, what have you got to say about those three reasons? There has been some confusion about those three reasons on cross examination—three, four and five, Page 15.

A. Well, those three are not the important three. Really the two reasons obtaining the minimum estimate are those covered under Items 1 and 2. I put them first because I felt they were the important ones.

Q. So far as you are concerned, the last three reasons there can be disregarded?

A. That's right.

Q. In other words, then, as I understand here as your testimony, you consider that you have given sufficient reasons in 1 and 2 to sell this proposition?

A. I think so, with the exception, Mr. March, I think that the information contained in one or two instances, one in particular, and I think in another, are the annual reports of the Texas Railroad Commission which indicate rather definitely something about the wastage of gas during the—particularly during the latter part of 1935 and the first part of 1936. For instance, in the 1937 annual report of the Railroad Commission of Texas and on the sheet following Page 14 of that report under the general heading of disposition there is a series of graphs—or, rather, a graph that shows that the Commission's orders for the utilization of available casing head gas did not occur until April or thereabouts in 1936 and that during the latter part of 1935 and up to about April 1936 there was a lot of gas blown into the air. This is simply in the form of a graph. It shows the withdrawals to be estimated in millions of cubic feet representing one ordinant of the graph and the years and months representing the other ordinant of the graph.

Now, it does show the reason is due to carbon black beginning in 1935 and going on through, but it also shows that during the latter part of 1935, particularly, that there was a considerable amount of gas which was not utilized even for carbon black. I can't state definitely how much of the gas that came from the ground actually was blown into the air during that period of time, but the interesting thing is that the Commission's orders for the utilization of available casing head gas apparently weren't issued until about April of 1936; so during the time between August 1935 and April 1936 there was unquestionably a lot of gas that was not metered and of which we had no record.

Mr. Keffer: May I make a statement with respect to the graph?

Mr. March: Go right ahead, Mr. Keffer.

Mr. Keffer: As a matter of fact, Mr. Hammer—

Mr. March: Are you going to cross examine the witness?

Mr. Keffer: I am just going to call his attention to what the map shows.

Mr. March: Well, you can do that on recross.

Mr. Keffer: All right.

The Trial Examiner: Did you state the year of that report, Mr. Hammer?

The Witness: Yes, August 1937.

Mr. Lange: You mean the date of the Railroad Commission report itself—November 1938.

Mr. March: You can ask one question, Mr. Keffer. A series of questions is what I had reference to.

Mr. Keffer: As a matter of fact, doesn't the graph show that the gas blown into the air started down *preciitously* from shortly before October, probably about the middle of September 1935?

The Witness: No, I think you are a month or two off—well, it would be up here some place in November.

Mr. Keffer: All right, November 1935, and hit the bottom in April 1936 and then started up a little.

The Witness: Yes, that's what the graph shows.

Mr. Keffer: And from November 1935 to April 1936 the volume of gas blown into the air decreased from more than 600 million in November of 1935, to probably no more than a hundred million in April 1936?

The Witness: That is true.

Mr. Keffer: All right, then, the statement that you just made that it didn't start until April 1936 is hardly a correct statement.

The Witness: I made no such statement. I said the

Commission's orders were to put into—were exercised about that time.

Mr. Keffer: What started it down back in April of 1936—

Mr. March: All right, I object to that. I was only consenting to a question here. If you want to argue with the witness you can argue with him when I am through.

Mr. Keffer: All right.

By Mr. March:

Q. I gather that all of those reasons are to be applied under your No. 2.

A. That's right.

Q. In other words, your position is that even since 1935 there has been a considerable wastage and unrecorded volumes of gas which you did not consider in your estimate of reserves?

A. That is absolutely true.

Q. Now, in regard to the statement you make on Page 15 of your written statement, they are merely observations as I gather it, are they not?

A. That is right.

Q. They are not an essential part of your estimate of reserves, are they?

A. No, they are not.

Q. All right, I next direct your attention to Exhibit 180, to the diagram on Page 4-B, entitled, "Illustration that Calculated Pressure Decline Conforms to the Pressure Decline Plotted Against Accumulated Production."

Have you turned to that yet?

A. Yes.

Q. Do you recall the discussion in regard to that, with Mr. Keffer, in regard to making a straight line—I mean a crooked line straight? You recall those discussions, do you not?

A. Yes, sir, very well.

Q. All right, Mr. Hammer, I will ask you with regard to that top line extending across the diagram there, from which side of the paper you started drawing that line?

A. Well, in this particular instance I plotted those points giving the slope of the curve on the calculated accumulated

withdrawals as against pressure declines, the calculated accumulated withdrawals being computed by the factor of 35.1 Mcf. per acre pound decline as applicable to the area covered by this curve.

Q. My question was, from which side of the paper you started drawing that top line extending across the diagram there.

A. It doesn't make any difference. I simply drew the curve through those points established by the method as I have indicated.

Q. Yes.

A. Then later on I plotted on there the actual accumulated production against the weighted pressure decline and the points thus plotted fell at their proper position on the curve.

Q. Those latter are represented by those little dots, is that right?

A. That is right.

Q. And the large circles represent your previous calculation?

A. That's right.

Q. So as a matter of practice, while it does not make any difference whether you start drawing the line—actually, you started, did you not, and you tell me whether I am right or wrong, from the right-hand side of the page and extended it over to the left-hand side of the page?

A. As I say, that makes no difference. The point is that I could have plotted those points on the production—the accumulated production—against the weighted pressure decline, either before or after the production projection of this curve and you would have had the same result.

Q. I notice all the large circles, they go right through the center.

A. That's true.

Q. Why is that?

A. Because the calculation of those points is an accurate mathematical calculation.

Q. Which is well established in the engineering fraternity?

A. That's right.

Q. Mr. Hammer, have you had a great deal of experience in calculating just such sorts of graphs such as this here?

A. I have made a great many graphs over a long number of years.

Q. In your experience have you had any graph that comes out any more nearly in a straight line than this graph comes out—I mean the points plotted the e on that, speaking of the left-hand side, the little points up there?

A. No, that is the reason we utilized the method that we did use, and that was to eliminate the personal element in the construction of a curve and relied solely on the mathematical determination of the proper slope.

Q. In other words, on the left-hand side of the page the little dots, although they do not fall exactly through the center, the line doesn't—as I understand it—that is, as I observe the thing here, every one of them at least touches the line?

A. They fall in their proper position to the line, either above or below.

Q. Now, why would you say that they did fall, some just slightly off the center of the line?

A. For the reason of the variations in the actual accuracy factors entering into the problem from time to time.

Q. In other words, on the left-hand side of the page here as I see it you have an indicated slope here which in so far as these mathematical calculations are concerned, they are used in the engineering fraternity, it is an excellent slope from which to determine—to project an accurate line?

A. I say, that it is the best slope that it is possible to devise to a given set of points that do not fall on a straight line.

Q. Now, you recall yesterday that there was a graph drawn for you by opposing counsel on which he plotted his pressure on one side of the rectangle and on the bottom of the rectangle he plotted years. Now is that sort of a graph in any respect comparable to this sort of a graph?

A. No. As I stated yesterday, from any practical standpoint on the question of estimation of gas reserves, the plotting of pressure points against time alone is of no value.

Q. This chart doesn't do that, doesn't attempt to do that?

A. No, not at all.

Q. Now, is this diagram here on Page 4-B a part of your estimate of reserves?

A. No. It wasn't necessary at all to even construct that. The only reason for constructing that was to illus-

trate the method used to determine a proper slope of a curve, and if that were calculated out it would give the proper answer as determined mathematically. It is simply illustrative of the method used. It was not necessary.

Q. You merely prepared this as a matter of accommodation?

A. That is right.

Q. To simplify the understanding of what you had done, and the same is true in regard to 4-C, is that right?

A. That is right.

Q. Now, Mr. Hammer, we have heard a great deal about drainage here. As I understand your position, and I think you have stated it several times in the record—if I am not right in my understanding I want you to correct it—that you did not consider separately and specially the problem of drainage in this exhibit. However, you had to, as I understand it, in drawing isobars, you automatically took into consideration dranage.

A. Well, the isobars is a misconception. There is a misconception about what isobars are. Isobars simply show lines of equal pressure. Now, when you step from one isobar line to another, either up or down, it simply shows the differential in pressure between those two isobar lines. If one will keep in mind the fact that you must make an estimate of reserves as of a certain time, then in utilizing the isobars in the determination of reserves as of a given time, it is not necessary to take into consideration, except as it may affect things locally, the question of any regional drainage.

Q. You recall that there was some discussion about this Lefors area, I believe it is, up here in Quadrant 6. I believe as I recall, and you correct me if I am incorrect, that you testified and you and Mr. Keffer agreed that there is a low pressure area there caused by excessive withdrawals, is that correct?

A. Yes, in the Lefors area there has been enormous withdrawals of gas and the pressures as of 1939 were quite low.

Q. Why, Mr. Hammer, if the gas moves freely from the high pressure to the low pressures, as Mr. Keffer assumes, why is it that this Lefors area in your opinion did not maintain its pressure? In other words, why didn't it drain to terrtory surrounding it and maintain its high pressures, and the high pressures be reduced around there?

A. That is simply—I think we can clarify that somewhat by stating that we take the area just along west and southwest of the town of Lefors. Now, it is a noticeable fact that although there have been enormous withdrawals of gas out of that area just west of the town of Lefors due to the large number of oil wells that exist there, it is a noticeable fact that the pressure gradient up against that low pressure area has been a steep gradient over a period of years, for several years, and that there still remains relatively high pressure areas up close to it.

In other words, it did not all rush into that area just west of Lefors because of a great pressure differential that existed there. It is a case, I think where the history of the last five years at least is that that pressure gradient has maintained approximately the same position throughout the five years, although there has been a decline for the region.

Q. So if there had been a free movement of gas in this one case here; for example—just take that exception—from the high pressure to the low pressure, then as the gas is withdrawn from this low pressure zone here causing the low pressure zone, the high pressure should have been maintained there because the gas would be coming in from all directions there?

A. The point there is that if there had been rapid gas migration the areas of low pressure would not have reached the low pressure that now exists because gas would have moved in and replaced it.

Q. All right, now, Mr. Hammer, would you say that this area down here in the east end of the field could drain gas from the Canadian River acreage?

A. Most certainly not.

Q. Would you say that it could drain gas from the west end of the field at all for any practical purposes?

A. Not at any time when any of ourselves would be living, no, or maybe a good many generations.

Q. Your position is—is it your position that for all practical purposes in estimating reserves that so far as Canadian River acreage is concerned that you can forget all about the eastern part of the field?

A. Oh, yes. It hasn't any bearing on it whatsoever. I agree with the position of the Texas Railroad Commission that for all practical purposes there is no direct actual con-

nection between the two, between the area from Lefors east and Lefors west.

Q. Is that your principal reason for stating that in estimating the reserves for the Canadian River acreage which is in the west part of the field that it is not necessary to make an estimate of the reserves of the entire field?

A. That is true.

Q. Now to bring this drainage problem home, Mr. Keffer tried to, when he said the Borger area here caused this—indicated on your map, Exhibit 179—the pressures in the Borger area were substantially lower than the pressures in the Canadian River acreage, that that was according to your map an indicated drainage, and as I recall you stopped him at one place and went over to the map here and pointed out that as a matter of fact—actual fact, the pressures in some of the Canadian River acreage was being maintained in practice in spite of the pressure differential.

A. I pointed out certain factual things there.

Q. You don't have to go over them. Is that generally true?

A. That is true.

Q. And in regard to your general knowledge, would you say, or could you state as to whether or not that if pressures were being maintained—high pressures were being maintained reasonably well in this Canadian River acreage in spite of the pressure differential between some of it and the Borger area?

A. Read that question.

(The question referred to was read by the reporter as set forth above.)

Mr. Spencer: Before you answer, Mr. Hammer, we have no objection to the question, but can you make it a little more definite as to what you mean by "reasonably well," so there will be no misunderstanding later, Mr. March?

Mr. March: Well, I'll let the witness answer the question and then I will ask a question in that regard. He can answer the question, if the question is clear to him.

The Witness: A question of that kind is a question of several factors which must be taken into consideration to arrive at a proper answer.

By Mr. March:

Q. You don't feel, then, that you want to give it?

A. At the present moment I would rather reserve my answer on that question.

Q. Well, you will not be expected to answer the question because as I understand you have not made a detailed study of the drainage problem.

A. No, my study has been a reserve study.

Q. And you would rather just let your testimony stand specifically in regard to certain parts of this acreage which you have already given?

A. For the present, that is right.

Q. Now, Mr. Hammer, one other question on this and that's all I have.

Now, if in spite of the pressure differential down here in the Lefors area the pressures did not build up enough there to maintain the pressures and they were not substantial reductions in pressures all around there as a result of that low pressure, is it reasonable to assume—is it less reasonable to assume that there would be any different situation in regard to the Borger area draining the Canadian River acreage?

A. That is a comparison again of so many factors entering into an answer it would have to be a relative answer. I would say, as I have tried to say before, and on which point I have a very definite impression, that if it had not been for the development of gas back from these oil fileds and if the gas withdrawals from the oil fields alone had been taken—had been the only cause of pressure decline, a great part of the entire Texas Panhandle field in my opinion would still have its original pressure.

Q. That's all of that I want to ask you, but I want to ask you one question in regard to sour gas.

There has been some question indirectly raised about the commercial utilization of sour gas for pipe line purposes. Do you think that sour gas can be utilized commercially for pipe line purposes?

A. Oh, yes, it is being done.

Q. By what process?

A. Well, there are several processes.

Q. I mean, what general process—desulphurizing?

A. Desulphurizing.

Q. Where is that being done?

A. It is being done by the El Paso Natural Gas Company.

Q. In your estimate of the reserves, therefore, you have included both sweet and sour gas?

A. That's right.

Q. From your study of the Panhandle field, would you state that if conditions continue as they are, assuming they do, that less and less sour gas will be utilized for carbon black purposes and more for pipe line purposes?

Mr. Keffer: Now, if the Examiner please, I would like to now what—if the witness is qualified to express an opinion as to what is going to be the future of sour gas service.

Mr. March: No, I said "assuming." I didn't ask him to give any—I said "assuming," like you did here yesterday time and time again, assuming that conditions remain as they are today, assuming that the trend continues as it is today, as to whether or not it is reasonable—whether or not in his opinion it would be a reasonable assumption to assume that a larger volume of sour gas would be utilized for pipe line purposes and that less volume would be utilized for carbon black purposes.

As a matter of fact, your company is going to put in a desulphurizing plant.

Mr. Keffer: You are getting away from your assumption, Mr. March. You first start out with an assumption and then you ask the witness to make still another assumption.

Mr. March: Read the question.

Mr. Keffer: I think it follows that you cannot base an assumption on an assumption.

Mr. March: Let's read the question and see how many assumptions I have got in the question.

(The record referred to was read by the reporter, as set forth above.)

Mr. Spencer: Now, Mr. Examiner, he has assumed the

conditions will continue, but those conditions I assume involve the market for carbon black. If so, I would like to know what the witness knows about the carbon black industry.

Mr. March: You can have him on redirect, Mr. Spencer. You can ask anything he knows about the carbon black business and the weight can be given the testimony as the Examiner sees fit. He has been asked lots of questions about carbon black, where it is located, and he has been examined for days about some of these very things. They can ask the witness whether he knows anything about it.

As a matter of fact, he was even required to state the process for the manufacture of carbon black, going through the various steps.

Mr. Spencer: I object to the question until Mr. March lays a proper foundation as to the witness' qualifications to answer.

The Trial Examiner: Well, I question whether or not a proper foundation for the question has been laid. However, the Examiner is perfectly able to weigh the evidence and Mr. Hammer, if he has an opinion, he may state it.

The Witness: Well, actually, I thought I made that clear previously. I will admit that I would have liked to have had time to make a study of the carbon black industry but I did not have time to, so I don't propose to set myself up as an authority on the carbon black industry in the Texas Panhandle. That's my position exactly.

By Mr. March:

Q. And you would rather not answer that question for the reasons that you have given to Mr. Keffer from time to time as the reason for not answering questions about these particular matters?

A. That is right.

Q. In your study, as I understand it, you did not give any consideration so far as this exhibit is concerned, as to where the gas went to?

A. That's right. My problem was to take the gas as near as I could as it came from the wells regardless of the

disposition of the gas afterwards. I made no study of disposition of gas.

Q. Now, there has been some questions asked you about permeability and porosity here. In your opinion can you express one of those in terms of the other?

A. Not at all.

Q. In your opinion that would be ridiculous, is that right?

A. Yes. There is a relationship, of course, but you can't express one in terms of the other.

Q. That is a fundamental law of physics, is it not?

A. That's right.

Mr. March: Now, I am just about through, Mr. Examiner, but I want to get a final ruling here as to whether or not in spite of the fact that the witness was interrogated regarding the Phillips Petroleum Company estimate of reserves, the method employed; whether or not the ruling is that I can't ask any questions in regard to that.

The Trial Examiner: Well, Mr. March, there is no connection between the Phillips Petroleum Company and the respondents in this proceeding. It is my opinion that it is highly improper to take a proceeding—

Mr. March: I don't mean that. I am forgetting about that. I am talking about something else. In other words, the witness was asked questions as to the method employed as to whether or not they were the same method and whether or not the field was divided up into quadrants and, in fact, as I read a few minutes ago—I am not going to read any testimony. I accept the Examiner's ruling on that, but I want to find out the extent of the Examiner's ruling. I want to know if I am going to be precluded from going into these things I have mentioned on redirect exemination.

The Trial Examiner: That is not the question. You haven't been precluded from going into the proper redirect, Mr. March. That is not the situation at all, but the question here is the propriety of the use of testimony.

Mr. March: I accept the Examiner's ruling on that. We have forgotten about that now. I want to know the extent of the Examiner's ruling. I didn't want to ask the witness until I found out because I thought it wise not to

impose on the Examiner in that regard if the ruling is that we are not to ask any questions in regard to the methods of the Phillips Petroleum Company estimating reserves in spite of the fact that those questions were brought up themselves by opposing counsel.

The Trial Examiner: Mr. March, it had been brought out that the Phillips Petroleum Company utilized the pressure decline method for estimating reserves in the field. At least, Mr. Hammer has testified to that. Now, if you have any redirect on that sort of thing, it is perfectly proper and the Examiner will go along with you on it.

* * * * *

The witness further testified on redirect examination, Vol. 61, pp. 8531-8540, as follows:

Q. Mr. Hammer, I believe you testified the other day that the Phillips Petroleum Company made an estimate of the reserves employing the pressure decline method very similarly to the way you employed it in your estimate.

A. That's right.

* * * * *

Q. Mr. Hammer, do you know of your own knowledge of anyone since 1935 who has attempted—who has made an estimate of reserves of the Panhandle field on the porosity thickness method other than Mr. Peterson and Mr. Thompson who are in this hearing room right now?

A. To my knowledge I don't.

Q. There is one other question, I believe, Mr. Hammer that you were requested to give the Canadian River—give the Canadian River a statement of original reserves under the Canadian River's own acreage. I believe you did comply with that request, did you not?

A. Yes, I gave them a sheet in tabulated form.

Q. Have you got that here?

A. It is on a yellow sheet, a long yellow sheet.

Mr. Spencer: I don't seem to have it.

Mr. March: He can get along without it.

Q. Mr. Hammer, in spite of the fact that the figures which you say that you gave to the Canadian River in the hearing room, will you state for the record the original

reserves under the Canadian River acreage as you found them, such explanation in regard thereto as you see fit?

A. The calculated original reserves in place beneath the Canadian River Gas Company's acreage as of August 1st, 1939, is 4,058,700,000 Mcf.

Q. Do you desire to make any explanation in regard thereto, Mr. Hammer?

A. Yes, I would like to make a comparison.

Q. You may proceed.

A. The calculated remaining reserves beneath the lands controlled by the Canadian River Gas Company as of August 1st, 1939 was 3,645,213,000 Mcf. at 25 pounds abandonment pressure, and on a pressure base of 14.65 pounds per square inch absolute.

The calculated original reserves in place beneath the same lands at the same pressure base as of the same date of August 1st, 1939, 4,058,700,000 Mcf.

Now, there had been withdrawn metered gas from the Canadian River Gas Company and predecessor company wells on the Canadian River leases from the beginning of operations up to August 1st, 1939, a total of 379,085,559 Mcf. of gas, calculated to a pressure base of 14.65 pounds absolute per square inch.

The remaining reserves beneath the Canadian River Gas Company lands as of August 1st, 1939 are calculated by the summation of reserves of that company's lands in each quadrant in which such lands exist and is 3,645,213,000 Mcf.

Mr. Keffer: What was that again? I'm not sure that I understood you, Mr. Hammer.

The Witness: 3,645,213,000 Mcf.

Mr. Keffer: Oh, yes. That's the figure you gave a while ago.

The Witness: Yes. If there be added to this sum the total gas withdrawn up to August 1st, 1939, or 379,085,559 Mcf., there results an original estimated gas in place of 4,024,298,000 Mcf. To recapitulate the ultimate original reserves in place by calculation, that is, by the summation of the calculations of their lands in various quadrants, 4,058,-700,000.

Then the ultimate original gas in place by adding the past withdrawals to future reserves, 4,024,298,000 Mcf., a difference of the ultimate reserve calculation of 34 billion cubic feet—the percentage of difference in the two methods of arriving at the original reserves in place is 85/100ths of one per cent.

By Mr. March:

Q. In your opinion, does that prove the accuracy of your method?

A. I think without any question it proves the accuracy of it. I submit that the method I have used is, therefore, accurate, fairly determined and that the principles used in the determination of the gas reserves are as accurate as it is possible to be done by the available supporting data. Had it been possible to get the past withdrawal from each total quadrant, or for the entire field, as in the case of the Canadian River withdrawals, it is my opinion that equally close results would have been attained. Now, that, I believe, sums up the accuracy of my calculation as far as reserves of Canadian River Gas Company are concerned.

Q. And, likewise, furnishes the information requested by the Canadian River Gas Company?

A. Well, I assume that that is what they want it for. I gave them the information, but this is my summation of what the data shows.

Now, with not so much certainty, but, nevertheless, with considerable accuracy, the same statement can be made as regard the reserves of the field as a whole.

Q. Is that all, Mr. Hammer?

A. No, I'm not through. As a matter of a similar check on the field as a whole, I wish to submit the following: The estimated future reserves by the summation of all quadrant reserves for the entire field, 22,599,000,000 Mcf.

Mr. Keffer: That's remaining?

The Witness: That's remaining, that's right. The estimated total withdrawals — no, the estimated total withdrawals for the entire field up to August 1st, 1935, amounts to a figure of 4,833,608,743 Mcf. The total withdrawals from the field from August 1st, 1935 to August 1st, 1939, amounts to 2,430,370,036 Mcf.

Now, if we will add the future reserves plus the estimated field withdrawals to August 1st, 1939, plus the withdrawals from August 1st, 1935 to August 1st, 1939, the sum of these three items amounts to 29,862,978,779 Mcf.

Now, the total estimated reserves by the summation of all quadrants, including Wheeler County 1, is 29,979,000,000 Mcf., a percentage difference between the two methods of computation of 38/100ths of one per cent.

Now, there is one point here that I want to clear up. The total field withdrawals—I beg your pardon. The estimated total withdrawals for the entire field up to August 1st, 1935, were—or, rather is an estimate that I secured from the Phillips Petroleum Company late in 1940 at the time I was sent to Bartlesville for the purpose of investigating certain records in connection with the application of the Independent Natural Gas Company. That figure was taken from their records with a photo record machine and the data I give here were taken from an enlargement of the photo record taken from the Phillips Petroleum Company.

The Trial Examiner: Are you sure you gave the right date there, Mr. Hammer? Did you mean 1939 or 1935?

The Witness: Total withdrawals, 1935, from the beginning up to 1935.

The Trial Examiner: You said 1939 and I thought that—

The Witness: That's right. Now, it is my opinion that having checked ultimate reserves in two cases, one by the summation of the ultimates for individual quadrants and the other by adding past withdrawals to future reserves, eliminates the possibility of any great error in my estimate.

Mr. March: That's all.

* * * * *

The witness explained that in order to get a calculated reserve figure he takes the drop in pressure between any two given points and divides this into the production for the same period, which gives him the volume of production represented by each pound lost in pressure, and then multiplies this by 430, the original virgin pressure in the field. The acre pound factor is simply a factor for weight-

ing the pressures and pounds, but it is also necessary to multiply by 430 after the value of each pound of pressure has been determined in order to get the original reserves.

Witness stated that he procured the Phillips figures in 1940, and also he had not used the Phillips figures in any manner in making his estimates. He did not know how he would have checked his work if he had used them. He stated that if he had used the Phillips figures he would have gotten about the same answer, but in that event his calculations would have had to check with the Phillips figures. In other words, if the Phillips figures had been utilized to determine the production per pound lost in pressure and then multiplied back by 430, the original field pressure, the matters would necessarily have checked because they were based upon the same thing whether the calculations were right or wrong.

The witness then stated that the assumption of accurate production figures in the Texas Panhandle Field from the beginning to August 1, 1935, was a theoretical thing because data was not available during that period, but assuming that the figures were available and had been utilized in making his estimate, his calculation figure as to past production would have to check with the actual figures of past production and neither could be a check upon the other because they are the same in both cases.

Witness further testified on recross examination (Vol. 61, pp. 8562-8576) as follows:

Q. That's the whole point. All right, now, when you get down to the point where you have one pound, weighted the way you have weighted it, one pound represents so much production; then if you had 430 pounds to start with, the original reserve would have to be 430 times that. It just couldn't be anything else but that, could it?

A. You have got to have in there the acreage, though.

Q. How do you mean, "the acreage"? The only thing you used the acreage for was in your weighting process. Now, we have the weight. You have used your acreage for that. Now we are beyond that.

The Trial Examiner: Mr. Hammer, for example, if you wanted to go back and ascertain the original reserves, what would be the last step in your method of computation?

The Witness: Well, we would take the difference in pressure between any two given periods of time and on the determination of the production per acre pound for the area considered we would utilize the difference in pressure, weighted against the acreage involved and from that determine the ultimate reserves in place.

By Mr. Keffer:

Q. All right, just take a very simple example and illustrate it, will you please, Mr. Hammer? I think we can all save time and all understand it better.

A. Well, the whole thing is that you have to have the difference in pressures, and you have to have the amount of acreage. Now, if you will multiply your acreage by the difference in your pressures and then multiply that by your production per acre pound decline, you will get your figure.

Q. Will you take just one of the Canadian River quadrants—any one you want to select, and show us just how that works on there, one that will work out the easiest?

A. There is an illustration right there all worked out in my exhibit.

Q. Not to get back to original reserves, Mr. Hammer. I am quite certain of that.

Mr. Spencer: Mr. Hammer, while you have been testifying here I have gone through these papers that Mr. Keffer has and I believe I have located the schedule that you handed to us, if it will help you any in this.

The Witness: That's it.

By Mr. Keffer:

Q. All right, now, let's take Hartley County, unless you would rather take another one—Hartley County. If it would work on one, the same thing would work on all the others, I take it. Now, show me how you got that original reserve figure.

A. Well, it is very plain here just as I described it. You have your Canadian River acreage; then you have your acre pounds as of 430, original.

Q. As of 430?

A. Yes.

Q. How would you get that as of 430?

A. Well, when you get—that means the difference between the pressure as of 1939 and the original pressure.

Q. All right, but you had to multiply somewhere in there by 430 to get that, didn't you?

A. Oh, no, you didn't.

Q. How did you get it?

A. By plain unadulterated subtraction.

Q. All right, subtraction from what?

A. The difference between the weighted pressure for 1939—August—and the original field pressure of 430 pounds.

Q. All right, we have 14,358 acres—Canadian River acreage, County 1, is that right?—Hartley County 1.

A. That is right.

Q. All right, then you have acre pounds of 430 in your next column, which is 6,173,940. Now, I want to know how you got that figure.

A. I have explained that so many times I don't think it is necessary.

Q. If you will just be patient with me, I'll try to be patient with you.

A. Well, in this particular case here it was calculated from 430 to well head abandonment, I think.

Q. That's right.

A. And in that case it would be your acreage and your difference between 430 and 25.

Q. Well, now, you just did that and didn't get the right answer, did you, Mr. Hammer?

A. Well, in that Hartley there, there is apparently a slight error.

Q. Multiply the 430. I don't know what you get. Let's try it. You got close on 405, you might get it on 430 if you multiply that. I don't know that you would. I haven't tried it.

A. That's right, I see where the error is.

Q. Then you do admit you multiplied by 430?

A. That gives it down to zero well head.

Q. That's right, that's what we have been talking about.

A. That's right.

Q. Well, then, are we agreed that even on your method you have got to multiply in there somewhere by 430 to get your original content at zero well head pressure?

A. That's right, you multiply. The only confusion here was that I thought it was down to 25, you see.

Q. I see.

A. And actually that column is to zero.

Q. Yes.

A. And then that zero was calculated back to 25.

Q. All right. Then when you get your pressure drop as related to your production and divide your pressure drop into your production you multiply back by 430 to get original content, zero well head pressure?

A. That's what this amounts to. Of course here after you get your acre pound factor, then, of course, you have to multiply that by your production per acre pound.

Q. That's right.

A. And that gives you your answer.

Q. Your acre pound is just the method you have of weighting the pressures, isn't it?

A. Weighting the pressures and the pounds.

Q. And getting your pressure drop with respect to your pressures.

A. That's right.

Q. But you always have got to come back and multiply by your 430 when you get that down to one pound pressure drop whether you do it one way or the other way?

A. You have to utilize, of course—if you are figuring back to any place you have got to utilize that pressure.

Q. We're together on the thing we have been arguing about most of the morning, I guess.

A. If you state your problem a little more clearly—

Q. I stated it as clearly as I could. I'm sorry if you didn't understand it.

The Trial Examiner: We'll stand in recess for five minutes.

(At this point a short recess was taken, after which proceedings were resumed as follows:)

The Trial Examiner: The hearing will be in order.

There is no question pending, is there?

Mr. Keffer: No. I thought that Mr. Hammer was figuring something. That's the reason I hadn't asked a question.

Q. Are you ready?

A. Yes, I guess so.

Q. Now, Mr. Hammer, we have got some of the underbrush out of the way. Let's go back to this original matter.

When you get your pressure decline over a period, whatever that period is, and if it is over several periods, and average them in, or weight them in as you have done and get your average weighted pressure decline and have your production for that period, you divide your pressure decline into your production and get the pressure decline, or get the production, rather, per pound decline, don't you, and multiply that by 430 and you have got your original reserves at zero pound well head?

A. I think that's what I have done here, that's right.

Q. That's right, all right. Now, the next question—then if you had gone back to the beginning of the field and taken Phillips' figures, for example, as the production prior to 1935 and taken your figures for production since 1935, thus having total production for the field as you have taken it and applied your method which you have done, I take it you would have come out with about the same figure that you have had?

A. I imagine I might have. The point there is, of course, I couldn't for the reason that the great part of all the calculations were completed before I ever got hold of the Phillips estimate of past withdrawals. I didn't get it until late in 1940 and the utilization of that was an afterthought, after I had secured the others—the principal calculations were all complete.

Q. Then, if you had done that, how would you have checked your work?

A. I don't know. I never used it.

Q. Well, I know, but if you had taken that figure and run it through together with your figure which you did, that is, the estimate for those prior years, plus your actual production figures as you have them for the later years, that is, from 1935 on to 1939; then on your theory, assuming that your method is right, you would have still come out with about 29 billion plus at 25 pounds abandonment, wouldn't you?

A. I think that is right.

Q. That's right.

A. The point is I didn't have them so I didn't use them.

Q. I know, I appreciate that. Now, that gets right down to this point: Then I take it you would have taken the

Phillips figures plus your own figures since 1935 and added them together and then added that to your remaining reserves on August 1, 1939 and you would have gotten the same figure, wouldn't you?

A. Well, now, aren't we getting a calculation and a summation mixed up?

Q. No, I don't think so. Maybe I can make it a little more clear to you. I have been trying to save ~~time and~~ take shortcuts. I'll break it up into sentences. All right, we'll take the Phillips production of—I mean the Phillips estimate which you have used here which is 4,883,680,740—somebody add that for me as we go along—up to August 1, 1935, and then we'll take your production figures as you have arrived at them since August 1, 1935 which is 2,450,370,036. Both of those are Mcf.

Now, the product of those two are what? That is, the sum is what? —All right, the sum of those two, someone tells me here, is 7,263,978,779. Now, that would have been your production figure as related to your pressure decline, wouldn't it?

A. From the beginning to—

Q. From the beginning to 1939, August 1, 1939.

A. If that figure is right, yes.

Q. All right, then, you have got your production per pound decline pressure drop; you have taken your decline over that period, weighted as you have weighted it, divided it into that 7,263,978,779, plus, Mcf., and you would have gotten your production per pound drop in pressure, wouldn't you?

A. That's right, taking into consideration all of the factors including your acreage.

Q Then you would have multiplied back by 430, wouldn't you, to get your original zero pound content of the reservoir or the quadrant, or whatever you were working on. In this case it would be the reservoir.

A. In other words, we are now talking about taking the production from the beginning to 1939?

Q. That's right, 1939.

A. And arriving at a factor there instead of using the latter part.

Q. That is it exactly.

A. I think in general—I think that is a true statement.

Q. All right, then you have come out—

A. If you were sure of your original data, or could be reasonably sure.

Q. Oh, yes, I understand that. All right, now, suppose that came out in round figures, to make it easier to keep in mind, 29 billion Mcf., when you multiplied back by 430. All right, when you made your original estimate of remaining reserves in 1939 you would still have had approximately—these are round figures—22 trillion remaining reserves, wouldn't you?

A. I think that's right.

Q. That's right. The difference calculated, we'll say, is 7 trillion, but the figure that you based the calculation on was also 7 trillion, wasn't it?

A. Under the conditions you are using, that is right.

Q. Under the conditions that I named. You based your calculation on 7 trillion, didn't you?

A. Under the conditions you mentioned, that's right.

Q. That's right, so, therefore, your calculations, right or wrong, would have to check with that method of checking, wouldn't it?

A. Under the assumption you are making, that's right.

Q. All right, have I made an unfair assumption?

A. I wouldn't say you had made an unfair assumption, but in this particular case and under the method that we have used, we could not arrive at the figure according to that method, because it could not—this production we are talking about prior to 1939 is a lump sum thing and could not under any conditions be properly allocated to the areas from which it came. In other words, it is a lump sum figure rather than a figure that can be properly distributed to the areas.

Q. I understand you could have broken it down had you been sufficiently interested to have gone back—

A. No, it couldn't have been done.

Q. Well, why couldn't it?

A. Well, that is a lump sum figure.

Q. All right, I don't know that that is so important anyway.

Now, this is the whole ~~thing about it,~~ Mr. Hammer: Let's assume a situation where you do have accurate figures from the beginning; you use those accurate figures as related to

your pressure decline. In other words, you divide your pressure decline into those accurate figures and you get so many billion feet for each pound loss in pressure; we multiply that back by 430 and get the original content of the reservoir at zero pounds well head; then that figure that you have used as a basis of that calculation, whether it is 7 trillion, whether it is 10 trillion, or whether it is 5 trillion, or whatever it is, is a constant figure in there, isn't it?

A. If you assume a theoretical proposition where you—

Q. I am not assuming a theoretical proposition, I am assuming a situation where you do have accurate records from the beginning, that's all I am—

A. As far as the Texas Panhandle field is concerned, it amounts to the same thing. It is a theoretical thing because you didn't have that data.

Q. If you want to call it theoretical, then we'll call it that, but that figure which you utilized to determine original content as well as remaining reserves, is the same figure, wasn't it? It is the only figure you had.

A. Yes, that is true.

Q. So when you added in the one case to original reserves to get original and deducted it in another from original content to get remaining reserves, the thing has got to balance one thousand per cent if you made your multiplication and division correctly?

A. If you did that, and not subject to any further check, I think that is true.

Q. That's right. All right, then you at least agree with me that on my theoretical figures here, as you prefer to call them, that you are comparing similar things and neither certainly could be a check upon the other since they are the same in both cases?

A. Under that sort of a condition I think so.

Q. That would be right?

A. I said it would.

Q. I beg your pardon, I didn't quite get it.

Then, if we assume for the sake of argument, which is a matter that, of course, will have to be determined in this hearing among others, that the pressure decline method does not operate properly in the Texas Panhandle field and gives you an erroneous figure, then the check which we have used here would not disclose the error, would it?

A. Under the method that you have set up, that is right.

Q. That is right. All right. Now, you have already stated, I believe, Mr. Hammer, that you did not consider any of the early estimates reliable; that is, estimates of production up to August 1, 1935.

A. In general that is true.

Q. Well, I take it that follows for the Phillips, or does it? Do you make an exception as to the Phillips?

A. That is simply a general check. I am not certain of it. No one can be certain of it but the position I took there was this: that if there is anybody operating in the Panhandle field that should have a fairly accurate check, I don't know how accurate it is, it would be the Phillips Petroleum Company.

Q. How about Canadian River? Don't you think we are pretty good, or not?

A. They're pretty good operators, I think.

Q. That's right.

A. The only thing is, though, that their interests are not scattered so thoroughly over the field and they are not in the same line of business in a big way that the Phillips are.

Q. But if the Canadian River had tried awfully hard over a period of years to get accurate figures on the field, you would think that they are entitled to some consideration, wouldn't you, Mr. Hammer?

A. Well, yes, perhaps some, but not as much as an operator where they had been operating in all phases of the industry right from the beginning.

Q. Well, suppose Canadian River had put more time on it than Phillips had, would you still think that bigness ought to control over the little pebble on the *beech*, such as Canadian River?

A. Not that, but the point is that—I remember very well at one time the Phillips Petroleum Company had the largest number of men employed in—what they call scouts, watching every conceivable condition throughout the field—the largest number of any company in there, and talking to these fellows, they admit that while theirs is the best that they can get, it is a long way, one way or the other, from being an exact figure.

The witness further stated that he could not be certain

about the Phillips figure for production prior to August 1, 1935, and that, as a matter of fact, Phillips admits that the figure is a long ways from being exact.

The witness stated that the east Texas Panhandle field was much more nearly depleted than the west Texas Panhandle field, but he did not think that operators in the east portion of the field would move to the west portion of the field for a supply of gas, but would more likely go to Hugoton, Kansas.

Witness further stated that he knew very little about conditions in the west Texas Panhandle Field with respect to shifting production from the eastern areas into the western areas, and that he did not know that as gas pressures became low along the northeastern flank of the structure that there was not enough gas produced in those areas for carbon black, and stated also that he did not know whether carbon black production in Moore County had increased since 1935. He just didn't check the carbon black production.

The witness further testified on recross examination (Vol. 61, pp. 8582-8588) as follows:

* * * * *

Q. All right, you don't know. Now, Mr. Hammer, you made the statement on your redirect examination on Saturday that every segment between your isobar lines contributed equally to the total average for each particular quadrant; that is, total weighted pressures for each particular quadrant.

Mr. March: I object to that. The question I asked was, on your hypothetical illustration of isobars every ten pounds on a hypothetical situation, not on this map up here.

Mr. Keffer: Your question was hypothetical.

Mr. March: Why, your original question was hypothetical and my questions here are hypothetical.

The Witness: May I explain what I think that was?

Mr. Keffer: All right.

The Witness: The only place where I utilized that expression as I remember was where we had that container

and were taking out a half of the gas and we got 200 pounds and 400 pounds and the point there was that they both contributed equally.

Mr. Keffer: I think that came later. I could be wrong about it, but I am just speaking entirely from memory. I haven't checked the record on it, but as I recall from your cross examination, I went into some detail and used Quadrant 1 of Potter County, not a hypothetical quadrant at all, Mr. March, but the actual quadrant with the isobar lines drawn on it just as Mr. Hammer drew them.

Mr. March: Oh, no, that wasn't the intention of the question at all. Here is what I really asked, if you want me to give it to you in the record to straighten it up. You will recall, Mr. Keffer, you said, "Let's assume that we have a quadrant with isobars on there all the way from 200 pounds to 400 pounds."

Mr. Keffer: That's right.

Mr. March: "And that you go in between 200, 210—" you recited the whole group in the record there.

Mr. Keffer: And which was Potter County Quadrant 1 as taken from his map.

Mr. March: I never used that at all.

Mr. Keffer: Those were the figures taken right off the map here.

Mr. March: Here is what I really asked him: The point was there that I was bringing out in the 400-pound segment that it contributes twice as much to the total factors as does the 200-pound segment, but each segment contributes equally to the average and you can read the record on that, and that is what I was bringing out.

Mr. Keffer: That's right. Now I want to take that up and see if it is. Now, a 400-pound segment—in fact, you have 430 in the southernmost segment of Quadrant 1 of Potter County—would contribute considerably more than the segment from 370, or 360 I should say, to 370 in the northeast corner of that segment, wouldn't it, simply because the pressures are greater; you have got a bigger multiple.

The Witness: It isn't comparable because you are leaving out a lot of other things there.

By Mr. Keffer:

Q. I am taking your segment here. By the way, before I forget it, I want to correct a statement. The 200 to 400 was not identical with the Potter County Quadrant 1. It runs, it looks to me like here, 360 to 435. There is that variation.

A. No, there is no 35 on there.

Q. I mean 430, I beg your pardon. Now, the higher the pressure in your quadrant—I mean in the segment, between isobar lines, the greater the, acre for acre—the greater acre for acre factor you would have for the—no, strike that. I'm getting a little balled up.

This is what I am trying to state: If you assume an equal number of acres in any particular quadrant—I mean in any particular segment of the quadrant, then the higher the pressure the greater will be the weight given to a particular segment?

A. No, they are all weighted out so that the segments contribute equally to the average.

Q. I know that is what you stated on your redirect Saturday. However, two or three days ago, after spending two or three hours on it, I think you finally said that a segment containing a thousand acres with 400 pound pressure would contribute just twice as much to your total aggregate figure as a segment of a thousand acres containing 200 pounds pressure, and we worked it all out to demonstrate it for your satisfaction.

A. That was your demonstration. As a matter of fact, the same statement would hold true there that while the 400 might contribute more, but when you come to the average of your 400 and your 200, they both contribute equally.

Q. Oh, I'm glad you made that statement. Then they both contribute 300, is that right—4 and 2 is 6, divided by 2 is 3.

A. That's right.

Q. All right, but in getting that 6 you multiplied your 200 by a thousand acres, you multiplied your 400 by a thousand acres, didn't you? You had, say, 400,000 in one, if it figures out that way, and 200,000 in the other, being 600,000 in all with an average of 300,000.

A. In your theoretical proposition, that is true, but as a practical matter in this Quadrant 1 you are talking about, or any other quadrant, it is not applicable.

Q. All right, now, just why isn't it?

A. Well, you are leaving out all of those intervening pressures there.

Q. I know, and that is what you said the other day.

A. I still say as far as I am concerned there is no use to argue about that.

Q. So we took time off, I went—I took segment after segment with 10-pound intervals and had you figure it all out and then had you compare the 200 with the 400 and it showed for the same acreage that the 400 was contributing twice as much to your total down there as the 200 was didn,t we?

A. Yes, but these are all weighted averages.

Q. I know, but if you will just follow me—but the 400 did contribute twice as much as the 200 to the product from which you obtained the average?

A. Yes, but each contributed equally to the average.

The Trial Examiner: How could they?

Mr. Keffer: How's that?

The Trial Examiner: I asked Mr. Hammer how could they.

The Witness: Well, if you—

The Trial Examiner: Assuming, now, that your acreage is the same.

The Witness: Well, take—

The Trial Examiner: I think what you have in your mind, Mr. Hammer, is that by taking your 10-pound steps the degree of difference is not so great as when you jump from 200 to 400, but it remains that if your acreage is the same that your acreage with the 400 pounds pressure contributes twice as much to your total as the acreage with the 200 pounds pressure

The Witness: Isn't it also true that if you strike an average, they both contribute equally?

The Trial Examiner: They may contribute equally in this way, that—

Mr. Spencer: They both give all they have.

The Trial Examiner: That's just the point. Isn't that the point, Mr. Hammer?

The Witness: Well,—

The Trial Examiner: But you feel that because you have taken these 10-pound steps that your weighted average brings the proper average, but nevertheless, it is also true, is it not, that your acreage with 400 pounds pressure contributes twice as much to your total as the acreage with the 200 pounds pressure?

Mr. March: Mr. Examiner—well, pardon me, you're not asking me the question.

The Witness: Well, I think perhaps the best way to answer that is this: We'll go back to Mr. Keffer's cylinder, and you take out—assume that cylinder was a thousand acres; and under his theoretical setup, you took out 1500—15,000 cubic feet and you had a pressure left of 200 pounds. Now, that 15,000 cubic feet was half of the gas. There also remained in that one-half of the gas, but at a changed pressure.

Now, the same amount of gas was in that container, but a changed pressure from that which had been drawn out of it: so the remaining gas in that contributed equally to the gas withdrawn.

Mr. March: Mr. Examiner, in your question did you assume that there would be more 400-pound acreage than 200-pound acreage?

The Trial Examiner: No, assuming the same acreage, a thousand acres.

The Witness: Does that clarify the situation?

The Trial Examiner: It doesn't clear it to me, but you can go on. Go ahead, Mr. Keffer. Pardon me.

The witness again stated that there was a great deal of unmetered gas in 1935 and 1936 which was not reflected in his production figures for that period, but that all of the gas shown by the Railroad Commission report for 1937 was metered gas.

The witness further testified on recross examination (Vol. 61, pp. 8590-8603) as follows:

A. I don't know how much of that gas from gasoline plants was going into the air. I do know that, except a lot of gas that was wasted, that the gas that went to the gasoline plants was, I think, without exception metered gas. The point is, though, that what I wanted to illustrate there was that although this order came into effect in 1935 and the law came into effect—I simply wanted to use this as an illustration—that it took from 1935 way over in to 1936 and then declining on beyond that, to the point where the Railway Commission had got more or less control of the situation. Now, during that early time while all of the gas to the gasoline plants—I think out of necessity was metered, at least the greater part of it was, there was also during that time a continued great wastage of gas that wasn't metered because control had not been had of the situation. Now, that's all I had in mind to illustrate.

Q. All right, then, to clarify the record, the chart which you referred to in the Railroad Commission report of 1937 and the observations you made with respect to the total volume of gas that was going into the air, had nothing to do with your estimates.

A. No, except that I wanted to illustrate that the Railway Commission, although it took some time after they had put in both of their orders, before they got control of the situation and during that time, outside of the gas that was metered, there was a very large wastage of gas.

Q. But all of the gas shown on the graph which you are referring to was metered gas?

A. I think that is true.

Q. In other words, they couldn't have shown it if it hadn't been, could they?

A. The point I wanted to make is to illustrate that they didn't get control of the situation.

Q. Well, I don't hardly see how that has anything to do with the problem. The impression I had, Mr. Hammer, and that is the only reason I went into it, was that you were referring to that large volume of gas as an evidence of great volumes that you had not taken into account in arriving at your estimate which would have a tendency to make it more conservative.

A. I think if you will go back over that, I attempted to correct that impression but the questions were shot at me so fast I was never given an opportunity.

Q. Well, I am sorry that I misunderstood. The whole point is that the gas you are referring to in the graph in the 1937 report was metered gas?

A. That is true.

Q. And, consequently, was considered in your estimate?

A. Yes, it was, but as I said, the thing was that it was during that period that there still was great wastage that was not metered gas.

Q. Now, as to the gas that was wasted into the air, unmetered gas, that was wasted during that period, do you have any idea about how much there was of that?

A. I haven't been able to check it out accurately. Sometimes the reports of the Commission give you figures that you can take off and sometimes the way they are set up they are so confusing that at least I haven't been able to interpret accurately what they mean.

Q. Well, all right. Now, you used Quadrant 3 of Potter County, Mr. Hammer, in constructing the curve which you have in your Exhibit 180, I guess it is.

A. Yes.

Q. Now, why did you pick out Quadrant 3, Potter County, upon which to construct that curve?

A. No particular reason that I remember. We just said, "We'll take Quadrant 3. It's as good as any."

Q. Take what?

A. We said, "We'll just take Quadrant 3 for example," and that's all.

Q. Did you try it on any of the rest of them before you selected Quadrant 3?

A. No, I'll tell you, we didn't have time to do a lot of trying.

Q. I see.

A. We just picked out a quadrant and worked it through.

Q. Now, the fact that Quadrant 3 has had a rather even decline in pressure would tend to make your line which you have drawn on the graph a straight line where some of the rest of them wouldn't, wouldn't it?

A. I don't think that is true.

Q. Well, isn't that obvious?

A. No, I don't think it is even obvious.

Q. Oh, it isn't. Well, tell me why it isn't, then.

A. Well—

Q. I say, if your pressure decline in Quadrant 3, Potter County, was more or less on a straight line, of course, when you plot it out it would give you a straight line, wouldn't it?

A. Well, the same thing would apply to any of the rest of them.

Q. If you had another quadrant that didn't plot out on a straight line, but a crooked line, with a curve tending to go down, down, down, much more than Quadrant 3, Potter County, you would have a harder time at least getting a straight line out of it, wouldn't you?

A. No, we are coming back to that old curve idea of yours about plotting pressure drop against time and that, it seems to me at least, is not applicable to a determination of gas reserves.

Q. Well, if you will answer me just this one question, we'll leave it. If you could pick out a quadrant where the decline did give you virtually a straight line and I could pick out a quadrant where the decline didn't give virtually a straight line, why, then there would be something there, wouldn't there?

A. Well, what do you mean, "be something there"?

Q. You would have a straight line in your case and a crooked line in mine.

A. No.

Q. Wouldn't we?

A. Of course, if you drew them you might, but not if I drew them.

Q. You can always draw a straight line even though it's a crooked one, is that the point?

A. Well—

Mr. March: I object to this line of questioning. We have gone far enough, I believe, with this fun. I'm having a lot of fun out of this myself.

By Mr. Keffer:

Q. As I understand, you didn't draw any curves on any of the rest of them?

A. Oh, yes, on two or three, just as a test; sure, but I

couldn't go ahead and project a curve on every darn group.

Q. How's that?

A. There is no necessity of going ahead and projecting a curve on every group. The only reason one was picked out was by way of demonstrating the method used.

Q. That's right. Of course, just as between you and me, we don't agree even on the one you picked out. That's clear to both of us, I guess.

A. You mean as between you and I?

Q. Yes, that's right.

A. I don't think—that isn't pertinent to the question.

Mr. Keffer: The only point, Mr. Examiner, I think the record is clear on it—I have contended that Mr. Hammer doesn't have a straight line even though he has drawn one, that he has ignored the points in order to draw a straight line and he says he hasn't, and there the record stands and there I am willing to leave it.

The Trial Examiner: Are you going to leave it there, Mr. Keffer?

Mr. Keffer: Yes.

The Witness: That's all right with me.

Mr. Keffer: All right. Now we'll go to something else.

Q. Now, Mr. March went into some detail with you on the matter of the Lefors area in Gray County, Mr. Hammer, with respect to the drainage question, do you recall that?

A. Well, there was some discussion about that, yes.

Q. That's right. You stated that the Lefors area had a very low pressure existant at this time.

A. That's right.

Q. And I believe either you or Mr. March stated, one or the other—I am pretty sure it is in the record—that there was no more reason for gas to drain from the Canadian River in the low pressure Borger area than it was for the Lefors to be repressured from the surrounding—

Mr. March: Let's get the record straight. I tried to get the witness to make that statement.

Mr. Keffer: Now, you did make the statement, I believe, also, Mr. Hammer, that if there had never been any produc-

tion in the Panhandle field except from the oil wells and other gas wells, some of them would be gas wells but primarily oil wells along the northwest flank of the structure, that there would today be great areas in the field that have virgin pressures, is that right?

A. Yes, I made that statement.

Q. And did you or did you not make the further statement that those pressures would always remain high in the absence of production, back in the higher pressure areas?

A. No, I don't recall making such a statement.

Q. All right, you do think, then, that even though there might have been high pressure areas in portions of the field that the production—heavy production along the northeast flank which created low pressures in that area, would in time have eaten its way back and destroyed the high pressures back to the southwest, even though there had never been any production from that area?

A. There the question of relative time comes in. Let me answer that this way: Ordinarily I wouldn't even have referred to the thing, but in this hearing so far I have heard so many judgment figures put in that I didn't see where it would do any harm for me to put in a judgment figure. Now, that was simply a judgment figure.

Q. And you yourself wouldn't want to rely much on it?

A. Well, that is my judgment, just like it is any man's judgment, and to go ahead and elaborate on it, I don't think it is necessary to elaborate on a person's judgment on a problem of this kind.

Q. Even though the judgment is bad?

A. I think it is better than some other judgments that have been put in this hearing.

Q. Well, if somebody expresses a bad judgment, still since it is his judgment, should it stand there at its face value?

A. Yes, it is his judgment, whatever it is.

Q. All right, now, when you did express that judgment, though, you were expressing some judgments about drainage, weren't you, unavoidably?

A. Yes, certainly.

Q. Now, you state that you made no study of drainage, and where it gets into other portions of the field you say you just can't answer because you haven't studied drainage.

A. That was just a general statement that anyone could go up there and study this thing a while and arrive at a judgment and say, "That's my idea."

Q. That is the very point I am coming to. Since it is a judgment figure as you have stated and not based upon any study, then you wouldn't expect the Examiner to take it as evidence. Now, isn't that a fair statement of your position?

A. Well, I think this, to be absolutely frank with you, that after having worked approximately two years on a program of this kind and whether or not you made a study—a particular study of drainage, you simply got certain impressions during that time of conditions that exist. You couldn't help it and I got a certain impression about a lot of things that aren't included in my estimate of reserves.

Q. I understand, but you, as an engineer—and an engineer must not make too many mistakes, to say the least of it—as an engineer, would not ask the Examiner or the Federal Power Commission to take your offhand impression as to what would happen to this high pressure?

Mr. March: Now, Mr. Examiner, at the very beginning of this cross examination he asked him if he made any special study of the drainage problem and the witness said no, yet Mr. Keffer is asking him what his opinion would be.

Now, Mr. Keffer has asked for his offhanded judgment and he has got his offhanded judgment and I will say that can stand in the record for what it may be worth in the Examiner's consideration. That's all anybody can do. If he is going to—maybe he will prepare an exhibit in rebuttal to your drainage exhibit, I don't know what he will do, but this drainage problem has nothing whatever as a separate problem to do with the exhibit under consideration here. The witness has said he has taken it into consideration in his isobars automatically. I object to any further questioning along that line, Mr. Examiner.

Mr. Keffer: I feel very much gratified that I have been referred to in a general way as Mr. March. Now, Mr. March said that I got that question out of the witness. As a matter of fact, it was Mr. March on his redirect examination, and that is the only reason that I am going into it. I didn't elicit it. Mr. March on Saturday morning in his redirect

examination got an answer from Mr. Hammer, if my memory serves me correctly, to the effect that if there had never been any production except along the northeast flank of the Borger area that great areas in the Panhandle field today would have virgin pressure.

The Witness: I think, Mr. Keffer, that I can clarify that.

Mr. Keffer: Sir?

The Witness: I think I can clarify that.

Mr. Keffer: All right.

The Witness : And I believe my clarification of this will relieve all stigma from either you or Mr. March. I volunteered it myself and no question was asked.

By Mr. Keffer:

Q. But Mr. March was asking the questions when you volunteered that, isn't that right?

A. Yes.

Mr. March: But you already asked a dozen questions about the same thing.

The Trial Examiner: Perhaps we can strike it and go on.

The Witness: As far as I am concerned, it can be struck out. I wasn't asked a question. I volunteered it, as I remember.

Mr. March: Let him stand on his own statement in the record.

Here it is on Page 8523 in the record:

"I would say, as I have tried to say before, and on which point I have a very definite impression, that if it had not been for the development of gas back from these oil fields and if the gas withdrawals from the oil fields alone had been taken—had been the only cause of pressure decline, a great part of the entire Texas Panhandle field in my opinion would still have its original pressure."

The Trial Examiner: Is that the statement you are referring to?

Mr. Keffer: That's right. That is the one I was examining him on.

Mr. March: We will agree that that may be stricken if there will be no more cross examination about drainage here in regard to this exhibit.

Mr. Keffer: I'm not going to make any agreement such as that.

Mr. March: All right. We object to any further cross examination about drainage.

The Trial Examiner: Well, the situation, Mr. March, is that this did creep in on redirect examination and I can't cut Mr. Keffer off on cross examination.

Mr. March: All right, we'll leave this right here, then, as far as we are concerned. We'll let it stand like it is in the record.

Mr. Keffer: All right. It is in and out and in and out and now it is in?

Mr. March: Now it is definitely in as far as we are concerned.

Mr. Keffer: All right.

Q. Now, Mr. Hammer, we can finish that in just a statement or two, I think. As I understand, you have already stated that that is based on no particular study on your part, purely an offhand impression.

A. That's right, a judgment figure like Mr. Rhodes put in and these others.

Q. But there was no study behind the judgment?

A. That's right, the same as in the other case.

Q. It's just like somebody out in the street or a tool dresser or somebody else might make the same statement, it gets down to about that point?

A. It is comparable to statements that were put in by Mr. Watson and Mr. Rhodes.

Q. By whom?

A. Mr. Watson and Mr. Rhodes' judgment figures.

The Trial Examiner: Never mind that, Mr. Hammer.

The Witness: All right, strike that out.

Mr. March: The question was asked whether or not it

was just like a tool dresser—in regard to a tool dresser in the oil field. He asked for that sort of an answer.

The Trial Examiner: Perhaps that question was out of place.

Mr. Spencer: I suggest that they both be stricken and let Mr. Keffer start again.

Mr. March: That is satisfactory.

The Trial Examiner: Very well.

The witness then again referred to the container examples and solved the problem contained in Exhibit 189 correctly by going back first to the original volumes and then using original volumes as the weighting medium and not the surface area, and also his computations were based on the known original content. He said it was not necessary to know this in estimating the future reserves in the Texas Panhandle Field.

The witness was then asked to solve the problem just as he did in estimating reserves in the field, which was as follows (Vol. 61, pp. 8607-8648):

Q. Now, Mr. Hammer, on redirect examination you worked one of the problems that I gave you but let the other one go unsolved. The other one was this, referring to Exhibit 189. I gave you a situation—

A. Just a moment until I get the exhibit out.

Q. The problem was this, take each of the three quadrants shown on Exhibit 189, and you had this problem: From Quadrant A there had been produced 15,000 cubic feet and there was 200 pounds remaining. In Quadrant B there had been produced 5,000 cubic feet and there was 300 pounds remaining. In Quadrant C there had been produced 2,000 cubic feet and there was 320 pounds remaining. Your original pressures in all three quadrants, your virgin pressure, was 400 pounds. Now, I want you to solve that problem just precisely as you solved the problem on the Panhandle field, with those known factors.

Mr. March: I object to that question: The witness has said a dozen times that these three containers aren't comparable to the detailed method with which he solved the problem. He can apply the principles he applied to the

whole field but to say he went through every movement he made in computing the reserves of the entire field would be to put the hypothetical to the real on which there has been an argument and haranguing about that for at least a half day on that very proposition.

Mr. Keffer: Let him apply the principles that he applied to the field.

Mr. March: In any case, it is clear in the record already that he is not going to be drug into a statement here that this is the field here, these three containers.

The Trial Examiner: I think the record is quite clear on that, Mr. March, and as I understand it, Mr. March, it is the mechanics of the calculation that Mr. Keffer wants.

Mr. Keffer: That is it exactly.

The Trial Examiner: Well, now, Mr. Keffer, didn't he work that very same problem for you on cross examination?

Mr. Keffer: He did, and he got an erroneous—I say, "an erroneous" answer, he got an answer of 69,000 plus where the answer only ought to be 60,000.

Mr. Spencer: 60,000.

Mr. Keffer: 60,000, yes. On redirect he didn't take up that particular problem but he did take up another one, and I am wondering if the same principle he used in the other one would apply to this one.

The Witness: I have that problem worked out.

By Mr. Keffer:

Q. How's that?
A. I have it worked out.
Q. Just like you worked it on the field?
A. Just as I would apply it to the problem you submitted.
Q. No, just apply the same principles you applied on the field.

Mr. March: Mr. Keffer is trying to force this witness to say that he is making the application as if he were making it to the field. Now, he will work the problem out—

The Trial Examiner: I think it is clear, Mr. March.

The Witness: Now, this is the problem where we had three cylinders?

Mr. Keffer: Quadrants.

Mr. March: Cylinders, we'll call them.

Mr. Keffer: Go ahead.

The Witness: —of different sizes, but with unknown content.

By Mr. Keffer:

Q. That's right.
A. But which have known original pressure.
Q. That's right.
A. And known pressure after the gas had been withdrawn.
Q. That's right.
A. 15,000 cubic feet withdrawn from Cylinder A; and the pressure gauge shows 200 pounds instead of 400 lbs. There has then been a decline of 200 pounds against a withdrawal of 15,000 cubic feet, or 75 cubic feet for each *pount* decline. 200 times 75 equals your 15,000 cubic feet. One-half of the pressure has been used; so there must be 200 pounds remaining or a volume of 2 times 15,000 or 30,000 at original pressure of 400 pounds. From Cylinder B—
Q. Now, wait just a moment. You are to apply the same principles you applied on the field and that is weighting them all in one against the other, Mr. Hammer.
A. That's what I'm getting to, but you must let me go through and arrive at this thing.
Q. Is that the way you did the thing on the field?
A. According to my own method of determination.

From Cylinder B there have been removed 5,000 cubic feet with an original pressure of 400 pounds and the metered pressure of 300 pounds. In that case one-fourth of the pressure, or one hundred pounds had been lost; then 5,000 cubic feet divided by 100 pounds equals 50 cubic feet per pound of pressure drop; then a hundred times fifty is 5,000 cubic feet. The remaining pressure is 300 pounds; then 300 times 50 is 15,000 cubic feet remaining. Then 15,000 cubic plus 5,000 cubic feet equals 20,000 cubic feet in Cylinder B at original pressure at 400 pounds.

In the case of Cylinder C there was also an original pressure of 400 pounds, the volume unknown, 2,000 cubic feet of gas was the remaining pressure gauge—no, and the pressure gauge showed 320 pounds or a decline of 80 pounds from the original pressure of 400 pounds. Then 2000 cubic feet divided by 80 pounds is equal to 25 cubic feet per pound pressure decline. 80 times 25 is 2,000. The gas withdrawn is then equivalent to the pressure loss. 80 pounds equals one-fifth of the original pressure, four-fifths or 320 pounds remain. 320 times 25 cubic feet equals 8,000 cubic feet which added to the 2,000 cubic feet withdrawn gives the 10,000 cubic feet originally in Cylinder C at 400 pounds.

We are back now to the point of where we know the original volume. We know the original pressure. It then resolves itself into this: We have three cylinders, one of 30,000 cubic feet, one of 20,000 cubic feet and one with 10,000 cubic feet or 60,000 cubic feet in all. From one—from the —well, I think I'll refer to these as A, B, and C, and that will keep it straight.

From Cylinder A we drew 15,000 cubic feet or the equivalent of withdrawing 15,000 feet from them. From Cylinder B we drew 5,000 cubic feet and from Cylinder C we drew 2,000 cubic feet. Now, all cylinders have their original volumes, but at a reduced pressure; hence, to properly solve the problem we have to weight each original volume against the reduced pressure as follows:

30,000 times 200 equals 6,000,000;

20,000 times 300 equals 6,000,000; and

10,000 times 320 equals 3,200,000, or a total volume pound factor of 15,200,000. Now, 15,200,000 divided by the 60,000,000 cubic feet originally in all three cylinders gives the weighted average pressure.

Then, 400 pounds minus 253.33 is equal to 146.666, or the weighted average pressure decline. The total gas withdrawn against this pressure decline is 22,000 cubic feet, which divided by 146.666 equals 150 cubic feet per pound pressure decline. Then 400 pounds times 150 cubic feet equals 60,000 cubic feet, the original gas in place at original pressure.

Q. All right, Mr. Hammer. You took each quadrant

separately and worked back to get its known content; then you took the known content and averaged it in, didn't you, to get the correct answer?

A. Let's see, now, you mean—

Q. In fact, you already had the correct answer way back in the middle by taking each one of them separately, didn't you?

A. No, I didn't. Taking each one of them separately I just had—

Q. Now, then, you got back to the original content and then you averaged the known original content, didn't you, of each quadrant?

A. No, of each cylinder.

Q. All right, of each cylinder, isn't that right?

A. No, in weighting them I weighted them all together.

Q. I know you weighted them all in on a volume basis and not on a pressure basis on this case here, yes.

A. On both a volume and pressure basis.

Q. Now, let's take that a step further and do it. Now, that isn't the way you did it in the Panhandle field, is it, or in any particular quadrant of the field, as you have explained many times?

A. Eventually we arrived at the future production, the future reserves, and in arriving at the future reserves by the method we used, it was not necessary to know the original content.

Q. That's right, and shouldn't be necessary here to know it, should it?

A. Well, it was my impression that you wanted this same figure back to original.

Q. I want the same principles that you applied in the Panhandle field with known pressures and known production records and known original pressures and see if you came back to the right answer, applying exactly the same principles you did on the Panhandle field, and that way we can test your principles as applied to the Panhandle field. That's all there is to it.

Mr. March: Is there a question pending?

Mr. Keffer: Yes, an explanation by Mr. Hammer.

Mr. March: What do you want him to explain?

Mr. Keffer: I want him to solve the problem exactly as

he solved the reserve problem on the Panhandle field and not in some other way.

Mr. March: This is his problem, of the Panhandle field. He has solved the problem on the Panhandle field here in his exhibit. He has testified time and time again as far as these three cylinders are concerned. That's just a hypothetical problem. Now, if you want to know his result of the entire field on the pressure decline method—you have been looking at this exhibit now for a week here, and you can look at it. We object to any further questioning along that line.

By Mr. Keffer:

Q. Mr. Hammer, let us take any quadrant—I am pointing to Quadrant 1 in Potter County, and we'll say—we'll say "cylinders" as a *compplimcnt* to you, and Mr. March, on the exhibit 189 that you were looking at. Let's say those three cylinders constituted one quadrant all interconnected.

Now, I want to get the weighted average pressure in that quadrant just as you did on Potter County 1.

Now, what you did there, as in all quadrants, was to take the area in each segment between each isobar line and multiply it by the pressure, wasn't it?

A. Yes, that is right.
Q. And you added them all up together, didn't you?
A. That's right.
Q. And then you divided by the acreage?
A. That's right. It gave you a—
Q. Weighted pressure?
A. That's right.
Q. Now, do that on this problem, just precisely that way.

Mr. March: I object to that. That has all been gone over before, Mr. Examiner. Even Potter County 1 was mentioned in this hypothetical situation. He has worked his hypothetical problem here for him and now he wants through implication and other direction, he is attempting to lay down a hard and fast rule covering this exhibit here, as a matter of fact where the exhibit speaks for itself.

Mr. Keffer: There is no question about the method. He is applying that method precisely to this problem that I have given him here, that's all there is to it, Mr. March.

Mr. March: He is computing the reserves in each one of these, in each one of—the reserves for each one, that's all been gone over.

The Trial Examiner: The objection will be overruled.

Mr. Keffer: Sir?

The Trial Examiner: The objection will be overruled.

Do you recall the question, Mr. Hammer?

The Witness: You want those weighted in?

By Mr. Keffer:

Q. Yes.
A. You mean to find the—
Q. Weighted average pressure just as you did on the Panhandle field.
A. I am assuming that each of these areas as we originally assumed is of equal size in acres.
Q. That's right.
A. Then, of course, it would be equivalent to multiplying each of them by one.
Q. That's right.
A. Which would give your acre pound factor.
Q. That's right.
A. Then I divide that—no, I take the summation of those acre pound factors and I divide it by the three acres which gives 273.33 as the weighted pressure.
Q. As the weighted pressure of the three?
A. Of the three.
Q. That's right. Now, you had 400 pounds pressure to start with, didn't you?
A. Yes.
Q. And 273 1/3 from 400 gives you 126 2/3 left as your weighted decline in pressure, doesn't it?
A. Covering that problem, yes, that is the difference.
Q. You have an average weighted decline of 126 2/3 and you have a total production of 22,000, don't you?—15 in A, 5 in B, and 2 in C?
A. Yes.
Q. All right. Then to get your production in pound decline you would divide your decline in weighted pressure, which is 126 2/3, into 22,000, wouldn't you?
A. By that method of calculation—if I have made my

calculations right, it would come out approximately 107—is that right?

Q. 107—173, isn't that right?

A. I hadn't carried it on out.

Q. Well, you can look at it. It ought to be 173.

A. Wait a minute, it is 107.

Mr. Spencer: Oh, no, it isn't.

Mr. Keffer: Oh, no, it wouldn't be 107.

Q. 173 cubic feet of production per pound decline in pressure as weighted, is that correct?

A. That is the way it figures out in that problem.

Q. Then to get your original content you would multiply that 173 by 400, wouldn't you?

A. Yes, on that problem.

Q. And that would give you a total of 69,200, wouldn't it, cubic feet original?

A. Yes, that comes back to the old thing, though, that we are only dealing with three of them here and there is an infinitesimal number of them in the field.

Q. Now, it is admitted, of course, that we are only dealing with three. Now, the way you have those averaged, those three, is just the way you averaged 789 or 10 in Quadrant 1, Potter County, isn't it?

A. Yes, against the acreage.

Q. And if you had only three quadrants—I mean, segments in that quadrant, then it is this—certainly as to the number, it would have been identical, wouldn't it?

A. Yes, but that's just the point. They weren't identical and they weren't—they aren't identical.

Q. Sir?

A. They weren't identical and they aren't identical, because if you go ahead and take enough of these containers or segments you eventually get to your—to the same figure. In other words, it will check out. It is not synonymous at all.

Q. I will ask you just one more question, Mr. Hammer:

If the principle would work on 10 it would work on 3, wouldn't it?

A. Yes, but you go on through with that to an infinity of containers and you will gradually approach—you will eventually approach a true figure.

Q. Well, now, as a matter of fact, I have given you in this assumed problem figures that do not vary as widely as the conditions in the field vary. I think you admitted that the other day when we were on it.

A. Well, that is an assumption. I don't think you can fairly draw a parallel.

Q. You don't think what?

A. I don't think you can draw—you can fairly draw a parallel.

Q. Well, the variation in pressure here was only from 200 to 320 and it is far more than that in the field, isn't it—pardon—more than that in practically every other quadrant up there?

A. If you are looking over a wide area proposition, yes, but of a local condition, no.

Q. Well, do you refer to a quadrant as a local condition?

A. Well, the term is relative. What I am talking about is a field-wide proposition without local areas. There are so many factors there, when you consider the thing as a whole, that aren't applicable local areas.

Q. Well, how did you take those different problems into consideration?

A. Just as I have previously, by grouping and by process of eliminating everything except adjacent areas eventually cover the whole field.

Q. That's right. Well, isn't that just all there is, haven't you gone the whole route now?

A. No.

Q. All right, what—

A. Oh, we are coming back to the number of these cylinders that you have to weight.

Q. Weight in—well, you say, then, that Boyle's law will not work on three cylinders but will work on ten, is that the point?

A. No, I made no such implication.

Q. What did you mean to say, then?

A. Just as I said before that you take enough of these things, of the so-called cylinders, and eventually weight them out properly as against the acreage and you will approach a true answer and eventually get it.

Q. How many do you need?

A. Well, I don't know. I never figured it was necessary to figure out how many you would need.

Q. Well, do you think five would do the job?

A. I don't know.

Q. Would you like to try it on five? Well, we can both do that some time when we have more time. I am willing to let the record stand on that as it is, Mr. Hammer.

Now we'll go on to one or two other matters. You made the statement—I'm not sure whether it was Saturday or whether or not it was some time during the course of your testimony—yes, I believe it was Saturday—that pressures were taken on wells sometimes before they had a chance to build up.

A. Yes, I think I made that statement.

Q. Now, in what kind of formation does that most likely occur?

A. Well, in general in an area of low potentiality I would say.

Q. That's right. The reason they don't build up is because of the tightness of the producing formation and maybe permeability or both?

A. And draw gas out rapidly and it takes a long time to get it back.

Q. It takes a long time to build it back up, doesn't it?

A. Yes.

Q. Now, does that indicate that those areas aren't as productive as some others?

A. No, not necessarily.

Q. What does it indicate?

A. It just indicates an area of low permeability.

Q. How is that—just an area of low permeability, is that your answer?

A. Yes.

Q. Does that indicate to you that the areas around the well are rather lean?

A. Well, it just indicates that.

Q. If permeability and porosity vary directly, it would indicate they were rather lean, wouldn't it?

A. Well, I have stated before that while there is a general relationship you can't convert one to the other. They aren't similar. They are two different things entirely.

Q. What is going to happen when the production shifts to those particular areas, Mr. Hammer?

A. Well, several things may be. Among other things, the first thing they will probably do on all those wells is

acidize all of them to increase the permeability around the hole.

Q. They didn't seem to see fit to do that over in Gray County as yet, I take it?

A. I don't know as to that. I think there has been some of it done, but I don't recall exactly the locality.

Q. Then apparently it would work?

A. I wouldn't say that.

Q. Well, you have that Gray County Quadrant 2, I believe it is, or 1. It is one of the other, Gray 1 or 2, that for the last three years of your study there hasn't been a foot of gas produced from it, yet there were wells there, isn't that true?

A. I think that is true maybe. My remembrance of it—

Q. Yes, I think that is very definitely the record in that case; so they haven't been able to do anything about it, or at least haven't done anything about it, have they?

A. Well, I think it was partly a case of where there wasn't any immediate demand.

Q. Well, of course, they drilled the wells for something, I take it, for some reason.

A. Well, naturally they were looking for gas. Probably some of them were looking for oil, I don't know.

Q. All right, let me state it this way, then: Those areas that you are speaking of where your pressures have not built up, the pressures have all gone down so rapidly with the production of gas, haven't they?

A. Yes, I think that is probably true.

Q. As a matter of fact, that is the reason they haven't built up, isn't it?

A. It indicates—it would indicate a slow movement of gas.

Q. All right, then; if you go to withdrawing heavily from those areas, won't your pressures drop more rapidly than would be true in the more prolific areas?

A. Well, I would say there that what you would have to do would be to drill more wells in an area of that kind.

Q. Well, the more wells you drilled the still more rapidly your pressure would drop?

A. It would all depend on your withdrawals.

Q. How's that?

A. It would all depend on your withdrawals.

Q. Well, I know. Maybe we were together. If you had

100,000 acres here in this tight formation and you pulled, say, a hundred million feet of gas out of it over a period of time and the pressures dropped very rapidly and never did build up—

A. They eventually build up.

Q. I know, but they build up slowly and drop rapidly.

A. All right.

Q. Then, if you had a well on every section in that one hundred thousand acres, wouldn't they drop more rapidly and build up still more slowly?

A. No.

Q. Why not?

A. If you took the same amount of gas out of each well—

Q. Why doesn't it drop more rapidly if you only had one well in that wide area?

A. Because you would be distributing the take from one well rather than from one or two.

Q. I don't think you understood. I am assuming the same volume of gas out of each well, not out of the area.

A. Well, you had not stated that.

Q. Well, I intended to. I thought you misunderstood me, the way you answered it.

A. Well, that's a difficult question to answer directly for the reason that you don't know and I don't, and no one knows what those wells are going to be until they are drilled.

Q. Oh, I know. I mean that judging from the wells we have. That's the only thing we can adjust it by.

A. Well, there has only been one or two places where wells have had much production taken out of them. I don't feel in position to judge what would happen to the others.

Q. Well, assuming that the others were of the same characteristics as the one well that you predicate your opinion upon; then the more wells you had in a given area the faster would be your production drop. Certainly it wouldn't be any slower.

A. If you took an equal amount of gas out of each well.

Q. That's right.

A. The drop would probably be more rapid ordinarily.

Q. And the buildup would be slower, too, wouldn't it?

A. Yes, I think that is true.

Q. So the net result of the whole thing is, when those areas come into production you are going to have a more

rapid pressure drop than you have in other areas where that situation does not exist. That is an *inescapible* conclusion, isn't it?

A. Well, as far as discussing that area down there, well, yes, that's all right.

Q. Wouldn't that apply to any other lean area of the field which has high pressures today?

A. Probably would.

The witness further testified (Vol. 61, pp. 8644-8648) as follows:

Q. All right, Mr. Hammer, the fact that in balancing your quadrants and to figure them out you necessarily use the inner quadrants sort of down the axis of the field as you referred to a while ago, which is admitted as the most productive area, wouldn't that have a tendency to make your reserve a little high?

A. There is a point where I can't agree with you.

Q. All right.

A. I have made a check on the famous Quadrant 2 that you mentioned in your previous questions, and if I have checked them properly, and I believe I have—

The Trial Examiner: Quadrant 2 where?

The Witness: In Moore County.

Mr. Spencer: Moore County or Potter County?

Mr. Keffer: Moore.

The Witness: Moore. Well, I can't find it, but I do recall this, that I think the record shows that you pointed out that I had used Quadrant 2, I believe.

Mr. Lange: Moore County?

The Witness: I think the record said nine times.

By Mr. Keffer:

Q. I think that's right.

A. Now, every time I used Moore 2, and not considering the quadrants in Potter County, but just the others, I use what you term the outside lean, ten times. Now, if I would use the Quadrants 1 and 2, say, in Potter County, I would have used the outside quadrants in my grouping more than

I did Quadrant 2. In other words, I would have used the leaner one more than I did the richer one.

Q. All right, now, just there, can you give any reason why you got a larger remaining reserve in Potter 1 and 2 than you have in Moore 1 and 2?

A. Well, that is because, particularly because of the lack of withdrawals. Those are future reserves only.

Q. High pressures, isn't it?

A. Yes, higher pressures.

Q. In weighting the higher pressures in there with large volumes of production up in 1 and 2 Moore County, now, isn't that the answer?

A. No, I don't think that can be interpreted that way.

Q. How would you intepret it?

A. Just as I have interpreted it in my—

Q. All right, now, you didn't apply a recovery factor to your figures. Wouldn't that have a tendency to make your figures too high?

A. Recovery factor isn't necessary when you are—there's no need of applying a recovery factor when you have already taken care of it automatically.

Q. I want to go a little further with that, Mr. Hammer. It has just been suggested that I should have asked you what outside quadrant did you use ten times. I believe you made that statement.

A. I didn't say I used any particular one, but I said I used outside ones, not necessarily the same one, but outside ones, what I think you considered and have mentioned as lean quadrants.

Q. Well, you used, then—it is all right, just so the record is clear—you used no particular outside quadrant, then, ten times that you know of?

A. I wouldn't want to say that I have without checking that.

Q. I don't see how you could, hardly.

A. But it doesn't make any difference whether I used a particular one or not if every time you used one of your what you term a rich one, you also used a lean one. It wouldn't make any difference whether it was the same one or not.

Q. All right. I don't mean to say I agree with you on that, but again I am letting the record speak for itself.

A. All right.
Q. So we can hurry on.

Now, on this recovery factor that we touched on just a moment ago, you said you didn't have to apply a recovery factor where you have an abandonment pressure.

A. As high as 25 pounds.
Q. And yet in your own written statement you have stated that 25 pounds at the face of the well, you are going to have considerably more pounds out away from the well, didn't you?
A. Yes, that is true.
Q. So in producing to 25 pounds at the well, you are going to have a lot more gas left in the reservoir than what that 25 pounds straight across would indicate, wouldn't you?
A. The estimate as set up here is an estimate of recoverable reserves to 25 pounds abandonment.
Q. Down to 25 pounds?
A. Well head gauge.

The witness further stated on redirect examination (Vol. 61, pp. 8653-8654) as follows:

Q. You remember that last little container problem that Mr. Keffer brought up, do you not?
A. Yes.
Q. I believe you stated time and time again that those little container problems that applied to your estimates here, it was ridiculous to make the application with them?
A. That is my judgment on it, that is right.
Q. Can you state in just a few words, not going into detail, just exactly and finally what that is?
A. Actually, by utilizing ten-pound isobars and using every effort possible to balance out and carefully weigh all of the factors affecting a given quadrant, every time we utilized a group of them it had the effect of reducing any infinity of these tanks to one tank, so that ultimately it came down to the problem of being comparable to a one-tank problem. It then simply became a problem of gas out as against the pressure drop. Every time we moved from one to the other to determine one group, or, rather, to determine the reserves for one quadrant in a group, it was equivalent to setting up a new one-tank problem. By the process of elimi-

nation we automatically carried out tanks step by step across the field and every time we worked out a problem we had a one-tank problem and it was just as though in applying the production per acre pound factor, you had taken a small part of a large tank and applied that to the weighted pressure for the quadrant in question. That is the whole thing and that is all there is to it.

The witness further stated that when lean areas come into production the pressure drop will be more rapid than in the case of areas of higher productivity.

The witness then gave the production figures on Wheeler County Quadrant 1 which had been requested, and which were 523,042 Mcf. for the four years ending Aug. 1939 (p. 8628). The production figures, acreage and acre pound factor of this quadrant are shown by Commission Exhibit 191, which is as follows:

Exhibit No. 191

Form No. F.P.C. ...
FEDERAL POWER COMMISSION

CALCULATION SHEET

Date ________ No. ________

Made by CEP

Checked by ________

Refer to WHEELER I   To Be Thrown Out

Q	PQ	Q^2
5568133	2.046846×10^9	3.100411×10^{13}
10403940	3.480118	10.824197
16420066	5.272483	26.961857
21369790	6.564799	45.666792
53761929	17.364246×10^9	86.553257×10^{13}

$1721.9 = 5a + 5.376193 \times 10^7 b$ $\qquad 1.075238 \times 10^7$

$17.3642 \times 10^9 = 5.376193 \times 10^7 a + 86.5533 \times 10^{13} b$

$18.5145 \times 10^9 = \qquad 57.8069$

$1.1503 \times 10^9 = \qquad 28.7464 \times 10^{13} b$

$$-\frac{1}{Ab} = \frac{28.7464 \times 10^{13}}{1.1503 \times 8.2636 \times 10^{13}} = 30.24$$

FEDERAL POWER COMMISSION DOCKET NO.
EXHIBIT NO. (FOR IDENTIFICATION)
DATE IDENTIFIED ....

Insufficient Production Data

FEDERAL POWER COMMISSION
....
Ex. No. ....
Introduced, ...

This is the best this can be photographed because it is very tightly bound.

Form No. F. P. C. 101
FEDERAL POWER COMMISSION

Exhibit No. 191

CALCULATION SHEET

Date ________ No. ______

Made by __________

Checked by __________

Refers to: WHEELER I

	ACREAGE	STEM LBS		PRODUCTION
WI	23576	10026800		
WII	59060	22326000		0
	82636	32352800	391.5	
WI		8533900		79105
WII		21840300		5489028
		30374200	367.6	5568133
WI		7903400		212266
WII		19740100		10191674
		27643500	334.5	10403940
WI		7551000		361324
WII		18979500		16058742
		26530500	321.1	16420066
WI		7137400		523042
WII		18246500		20846748
		25383900	307.2	21,369,790

This is the best this can be photographed because it is very tightly bound.

The production for each yearly period may be determined from the above Exhibit. The total acreage in the quadrant is 23,576, and the acre pound value for the quadrant is 30.24.

The witness was excused.

Some three days later the witness was again placed on the stand by Commission Counsel and gave some further testimony with respect to the question of reserves, and over the objection of counsel for Canadian River, the following proceedings were had (Vol. 64, pp. 9187-9188):

> "Q. (Mr. March Commission Counsel) Mr. Hammer, does your Exhibit 180 show in your opinion the remaining recoverable reserves of the Canadian River acreage?
>
> A. I think so. That is what I intended. As a matter of fact, I think the record will show that Mr. Keffer asked me on cross examination the other day if I considered a recovery factor and at that time I said I considered that by choosing an abandonment pressure that that abandonment pressure automatically took care of recovery factors and I hadn't used one.
>
> Q. I understand your estimate of reserves is not only the remaining reserves that the Canadian River has under its acreage but likewise reserves which could be recovered?
>
> A. That was the intent of the entire thing, the recovery to 25 pounds.
>
> Q. I would like to ask you the same question in regard to your exhibit which shows the estimate for reserves in the field as a whole.
>
> A. That would apply the same."

Thereafter the witness HAMMER identified his Exhibit No. 294, entitled "Basic Data on Quadrants in which Canadian

River Gas Company Leases are Situated," and Exhibit No. 295, entitled, "Production Data, Hartley, Moore, Potter, Hutchinson and Carson Counties, Texas," which exhibits were subsequently admitted in evidence.

Exhibit 294 contains all of the wells in Canadian River Gas Company quadrants up to August 1, 1939. Exhibit 295 contains a breakdown by years of the production data which is recorded in previous exhibits.

The witness testified with respect to Exhibits Nos. 294 and 295 (Vol. 101, pp. 15567-15591) as follows:

BASIC DATA ON QUADRANTS

IN WHICH THE CANADIAN RIVER GAS COMPANY LEASES ARE SITUATED

Name of Company (1)	Well Name and Number (2)		Year of First Withdrawals (3)	Total Metered Gas All Time To August 1, 1939 (4)	Total Gas Metered August 1, 1935 To August 1, 1939 (5)	Metered Gas Prior to August 1, 1935 (6)	Location Sec. (7)	Location Block (8)	Location Survey (9)	Pressures* 1935 (10)	Pressures* 1936 (11)	Pressures* 1937 (12)	Pressures* 1938 (13)	Pressures* 1939 (14)	Pressures* 1940 (15)	1935** Potential MCF (16)	1939** Potential MCF (17)
																	Quadrant No. 1 Potter County
adian River Gas Company	Bivins	C-1	1923	8,060,120	1,230,290		106	46	HATC	421	424	418	416	411	409	9,383	10,078
" " " "	"	A-3	1923	15,249,436	4,956,986		30	M-20	GAM	402	342	-	392	385	379	10,341	14,433
" " " "	"	C-4	1924	3,115,153	682,809		103	46	HATC	420	418	-	406	405	392	5,520	4,647
" " " "	"	D-3	1923	4,544,833	878,678		15	M-20	GAM	409	411	401	399	390	378	9,765	8,483
" " " "	"	A-16	1936	3,825,095	3,825,095		33	M-20	GAM	-	345	-	390	390	378	18,575	12,895
" " " "	"	A-18	1937	3,341,298	3,341,288		17	M-20	GAM	-	-	-	397	391	386	15,933(2)	13,630
" " " "	"	A-19	1937	3,068,214	3,060,214		29	M-20	GAM	-	-	-	397	386	381	17,279(2)	13,597
" " " "	"	A-30	1938	1,909,551	1,909,551		35	M-20	GAM	-	-	403	397	385	380	11,507(2)	7,432
										-	-	401	398	390	390	5,450(2)	4,837
" " " "	"	A-23	1937	424,170	424,170		8	22	ELRR	-	-	-	415	343	365	10,137(3)	6,013
										-	-	-	-	-	400	-	-
" " " "	Masterson	B-3	1939	17,533	17,533		42	3	GAM	-	-	-	-	385	372	-	37,984
" " " "	"	B-5	1922	1,738,904	0		31	3	GAM	411	416	414	-	408	400	5,458	5,265
" " " "	Warrick	A-1	1929	4,254,420	1,144,281		16	Y-2	TTRR	364	375	372	369	365	352	50,701	58,976
" " " "	McBride	A-1	1931	1,017,522	590,141		98	46	HATC	411	406	400	395	386	377	37,213	35,507
" " " "	Allison	A-1	1930	906,166	114,755		1	WT	Palmer Sur.	382	380	374	369	365	356	26,244	23,376
Total				51,472,405	22,183,791	29,288,614										181,300	257,093
andle Eastern Pipeline Co.	River Bed	1	1931	1,979,173	1,555,510		106	46	HATC	425	422	420	416	409	397	10,893	21,216
" " " "	Weymouth	1-37	1931	3,069,702	1,961,062		37	B-10	ELARR	416	411	409	404	388	379	31,552	28,721
" " " "	Rock Well	1-102	1931	1,239,065	899,809		102	46	HATC	416	408	393	394	394	380	8,275	8,126
" " " "	McBride	1	1935	2,098,079	2,098,079		100	46	HATC	-	-	395	393	393	378	45,231	30,546
" " " "	McBride	1-104	1938	665,794	665,794		104	46	HATC	-	-	-	-	404	390	-	38,207
Total				9,051,813	7,180,254	1,871,559										95,952	126,816
River Gas Company	Bivins	A-1	1926	2,466,194	1,070,564		42	M-20	GAM	404	399	393	385	375	370	12,564	12,189
" " "	"	B-1	1927	1,800,372	1,214,089		39	M-20	GAM	409	404	400	392	382	374	32,678	24,674
" " "	"	A-2	1929	4,890,510	3,477,107		39	M-20	GAM	408	404	399	392	383	374	58,995	50,458
" " "	"	A-6	1935	873,125	869,929		37	M-20	GAM	412	406	404	394	384	379	13,817	8,689
" " "	"	A-7	1935	2,111,996	2,102,753		38	M-20	GAM	409	405	401	392	333	376	28,737	24,674
Total				12,142,097	8,734,442	3,407,655										146,791	120,684
ND TOTAL				72,666,315	38,098,487	34,567,828											
																	Quadrant No. 2 Potter County
adian River Gas Company	Masterson	C-1	1923	559,816	170,875		65	O-13	D&P	410	410	400	405	396	391	1,592	1,900
" " " "	"	C-3	1923	7,406,511	2,249,464		102	O-13	D&P	416	417	416	415	403	401	-	7,367
" " " "	"	D-4	1922	30,746,151	11,103,576		108	O-13	D&P	415	405	398	388	385	377	156,371	92,150
" " " "	"	E-2	1923	1,168,019	479,510		70	O-13	D&P	403	403	400	398	393	386	2,688	2,743
" " " "	"	F-1	1925	779,377	506,772		14	3	GAM	419	418	412	415	413	405	4,250	3,752
" " " "	"	G-2	1925	1,100,779	541,103		10	3	GAM	402	375	390	386	390	375	6,642	5,126
" " " "	"	H-1	1925	1,082,166	823,613		2	B-11	ELRR	412	413	-	-	-	-	1,308	-
										416	418	396	414	407	402	2,552	2,167
" " " "	"	I-1	1925	1,293,374	920,987		20	3	GAM	419	419	413	412	409	404	28,830	24,815
" " " "	"	J-2	1929	1,879,973	733,051		69	O-13	D&P	419	416	410	410	395	399	8,165	6,166
" " " "	"	K-1	1929	2,087,963	1,350,861		85	O-13	D&P	406	418	401	403	390	384	8,993	8,225
" " " "	"	L-1	1928	634,762	502,327		82	3	GAM	40?	403	392	395	397	396	2,479	2,474
" " " "	"	N-1	1930	2,670,967	2,583,350		17	3	GAM	418	415	407	405	404	380	22,541	24,205
Total				51,309,858	21,970,489	29,339,369										246,411	181,090
andle Eastern Pipeline Co.	Masterson	1-85	1931	880,688	692,613	188,075	85	3	GAM	414	415	410	404	397	388	3,981	10,293
ND TOTAL				52,190,546	22,663,102	29,527,444											

* Well head gauge closed in pressures from Texas Railroad Commission official records.
** Well potentials (open flow) from Texas Railroad Commission official records.
***: All volumes of gas in MCF. Prior to August 1, 1935 pressure base unknown. Subsequent to August 1, 1935 all gas on a pressure base of 14.65 lbs. per sq. in. absolute.

1936 marked (1) First pressure and potential.
1937 " (2) " " " "
1938 " (3) " " " "

BASIC DATA ON QUADRANTS

IN WHICH THE CANADIAN RIVER GAS COMPANY LEASES ARE SITUATED

Name of Company (1)	Well Name and Number (2)		Year of First Withdrawals (3)	Total Metered Gas All Time To August 1, 1939 (4)	Total Gas Metered August 1, 1935 To August 1, 1939 (5)	Metered Gas Prior to August 1, 1935 (6)	Location Sec. (7)	Location Block (8)	Location Survey (9)	Pressures* 1935 (10)	Pressures* 1936 (11)	Pressures* 1937 (12)	Pressures* 1938 (13)
adian River Gas Company	Bivins	A-6	1936	1,966,554	1,966,554		32	B-11	ELRR	424	407	403	414
" " " "	"	A-15	1936	1,523,385	1,523,385		76	2	G&M	-	413	406	411
" " " "	"	A-17	1936	859,827	859,827		73	2	"	-	416	417	413
" " " "	"	A-24	1939	1,369,446	1,369,446		23	P.Mc	ELRR	-	-	-	-
" " " "	Killgore	A-1	1930	3,720,129	3,657,456		18	"	"	421	402	408	405
" " " "	"	B-1	1931	2,201,736	1,475,053		22	"	"	419	418	416	411
" " " "	"	A-2	1937	2,657,367	2,657,367		20	"	"	-	-	409	392
" " " "	Seay	1	1929	856,477	471,302		85	2	G&M	421	418	414	411
Total				15,154,921	13,980,390	1,174,531							
uma Natural Gas Company	J. W. Moore	1-P	1935	6,288,497	5,845,580	442,917	14	44	H&TC	413	407	404	399
AND TOTAL				21,443,418	19,825,970	1,617,448							
adian River Gas Company	Bivins	A-7	1936	4,368,070	4,368,070		7	24	ELRR	-	423	421	414
" " " "	"	A-8	1929	2,261,507	2,236,583		BH M 4	25	ELRR	- 426	- 427	- 425	- 424
" " " "	"	A-9	1929	76,819	48,508		BH L 6	21	CSS	- 422	- 422	- -	- 415
" " " "	"	A-10	1930	78,760	33,803		18	2	G&M	425	425	-	385
Total				6,735,156	6,686,964	98,192							
adian River Gas Company	Bivins	A-2	1925	7,284,740	4,056,889		13	0-18	D&P	402	373	386	385
" " " "	"	A-4	1928	868,651	707,138		24	0-18	"	407	358	381	385
" " " "	"	A-5	1929	5,237,627	4,204,491		25	0-18	"	418	407	-	395
" " " "	"	B-1	1929	3,396,371	1,504,269		27	0-18	"	421	423	411	412
" " " "	"	A-13	1936	353,176	353,176		7	0-18	"	422	420	423	427
" " " "	"	A-14	1936	11,074,381	11,074,381		26	0-18	"	-	420	393	406
" " " "	"	A-25	1939	60,816	60,816		2	0-18	"	-	-	-	-
" " " "	Crawford	B-1	1932	3,115,157	1,182,143		78	0-18	"	420	422	416	415
" " " "	Coughlin	A-1	1937	531,901	531,901		BH L 1	0-18	"	- -	- -	405 400	416 416
Total				31,922,820	23,675,254	8,247,568							

* Well head gauge closed in pressures from Texas Railroad Commission official records.
* Well potentials (open flow) from Texas Railroad Commission official records.
tes: All volumes of gas in MCF. Prior to August 1, 1935 pressure base unknown. Subsequent to August 1, 1935 all gas on a pressure base of 14.65 lbs. per sq. in. absolute.

1936 marked (1) First pressure and potential
1937 " (2) " " " "

Exhibit No. 294

BASIC DATA ON QUADRANTS

IN WHICH THE CANADIAN RIVER GAS COMPANY LEASES ARE SITUATED

	Year of First Withdrawals (3)	Total Metered Gas All Time To August 1, 1939 (4)	Total Gas Metered August 1, 1935 To August 1, 1939 (5)	Metered Gas Prior to August 1, 1935 (6)		Location Sec. (7)	Location Block (8)	Location Survey (9)	Pressures* 1935 (10)	Pressures* 1936 (11)	Pressures* 1937 (12)	Pressures* 1938 (13)	Pressures* 1939 (14)	Pressures* 1940 (15)	1935** Potential MCF (16)	1939** Potential MCF (17)
																Quadrant No. 3 Moore County
A-6	1936	1,966,554	1,966,554			32	B-11	ELRR	424	407	403	414	388	387	9,903	6,267
A-15	1936	1,523,385	1,523,385			76	2	G&M	-	413	406	411	403	394	6,230(1)	10,456
A-17	1936	859,827	859,827			73	2	"	-	416	417	413	414	409	5,025	2,400
A-24	1939	1,369,446	1,369,446			23	P.Mc	ELRR	-	-	-	-	403	396	-	30,395
A-1	1930	3,720,189	3,657,456			18	"	"	421	402	408	405	384	372	34,336	22,663
B-1	1931	2,201,736	1,475,053			22	"	"	419	418	416	411	404	390	8,352	5,033
A-2	1937	2,657,367	2,657,367			20	"	"	-	-	409	392	390	385	23,367(2)	14,901
1	1929	856,477	471,302			85	2	G&M	421	418	414	411	403	396	10,486	8,563
		15,154,921	13,980,390	1,174,531											68,102	100,678
1-P	1935	6,288,497	5,845,580	442,917		14	44	H&TC	413	407	404	399	387	-	31,273	18,616
		21,443,418	19,825,970	1,617,448												
																Hartley County
A-7	1936	4,368,070	4,368,070			7	24	ELRR	-	423	421	414	415	407	20,546	19,658
A-8	1929	2,261,507	2,236,583		BH	4	25	ELRR	-	-	-	-	423	-	-	9,500
					M				426	427	425	424	423	420	43,477	8,000
A-9	1929	76,819	48,508		BH	6	21	CSS	-	-	-	-	423	419	-	8,586
					L				422	422	-	415	429	419	8,818	1,230
A-10	1930	78,760	33,803			18	2	G&M	425	425	-	385	382	391	3,294	1,574
		6,735,156	6,686,964	98,192											76,133	48,548
																Quadrant No. 3 Potter County
A-2	1925	7,284,740	4,056,889			13	0-18	D&P	402	373	386	385	386	368	17,988	16,528
A-4	1928	868,651	707,138			24	0-18	"	407	358	381	385	356	365	5,900	1,333
A-5	1929	5,237,627	4,204,491			25	0-18	"	418	407	-	395	400	399	12,634	11,579
B-1	1929	3,396,371	1,504,269			27	0-18	"	421	425	411	412	412	406	30,657	28,686
A-13	1936	353,176	353,176			7	0-18	"	422	420	423	427	414	411	5,291	4,449
A-14	1936	11,074,381	11,074,381			26	0-18	"	-	420	393	406	405	400	43,320	39,037
A-25	1939	60,816	60,816			2	0-18	"	-	-	-	-	410	403	-	27,790(Estd.)
B-1	1932	3,115,157	1,162,143			78	0-18	"	420	422	416	415	413	404	10,427	9,287
A-1	1937	531,901	531,901		BH	1	0-18	"	-	-	405	416	413	404	4,645(2)	4,571
					L				-	-	400	416	412	412	16,260(2)	14,116
		31,922,820	23,675,254	8,247,568											126,217	157,376

1936 marked (1) First pressure and potential
1937 " (2) " " " "

...m Texas Railroad Commission official records.
...Railroad Commission official records.
...August 1, 1935 pressure base unknown. Subsequent to August 1, 1935
...lbs. per sq. in. absolute.

Exhibit No. 294

BASIC DATA ON QUADRANTS

IN WHICH THE CANADIAN RIVER GAS COMPANY LEASES ARE SITUATED

Quadrant No. 1
Moore County

Company (1)	Well Name and Number (2)	Year of First Withdrawals (3)	Total Metered Gas All Time To August 1, 1939 (4)	Total Gas Metered August 1, 1935 To August 1, 1939 (5)	Metered Gas Prior to August 1, 1935 (6)	Location Sec. (7)	Location Block (8)	Location Survey (9)	Pressures* 1935 (10)	1936 (11)	1937 (12)	1938 (13)	1939 (14)	1940 (15)	1935** Potential MCF (16)	1939** Potential MCF (17)
[illegible]r Gas Company	J. T. Sneed A-D	1926	1,179,300	561,493		[illegible]	6-[illegible]	T&NO	403	403	390	389	376	361	7,206	6,057
" " "	Sneed 1C	1930	731,564	523,427		[illegible]	6-[illegible]	T&NC	401	403	394	392	386	372	17,168	11,971
" " "	Masterson A-1	1929	6,922,082	2,739,539		46	3	G&M	386	336	380	378	366	360	12,276	14,061
" " "	" A-2	1929	26,838,874	10,095,127		[illegible]	3	"	395	349	-	377	369	360	37,584	32,003
" " "	" B-1	1929	17,793,730	9,547,896		43	3	"	-	-	390	380	374	366	45,347(2)	46,523
" " "	" M-1	1930	2,818,396	1,546,534		1[illegible]	[illegible]-10	ELRR	400	400	392	390	390	368	5,561	4,988
" " "	" A-3	1936	9,214,508	8,214,508		45	3	G&M	-	326	385	379	369	359	41,296	24,695
" " "	" A-4	1939	499,065	499,065		33	F-[illegible]	ELRR	-	-	-	-	385	371	-	55,508
" " "	Bivins 1-[illegible]	1933	2,625,897	1,282,483		93	46	H&TC	372	364	342	352	343	342	34,410	23,766
" " "	" 1-H	1933	2,764,732	1,363,527		[illegible]	46	"	382	3[illegible]0	369	390	360	353	26,710	21,968
" " "	" I-1	1934	4,014,479	1,614,541		4		G. Lanan	379	381	373	367	363	356	27,591	27,398
" " "	" J-1	1933	5,957,479	4,000,451		54	47	H&TC	391	389	379	372	369	359	60,543	60,401
" " "	Warrick A-2	1930	3,023,330	1,213,115		92	46	"	376	-	370	360	353	349	70,140	60,930
" " "	Read [illegible]-1	1930	3,137,683	762,163		14	B-12	D&P	385	-	335	385	370	358	12,285	11,272
" " "	" A-2	1938	205,937	205,937		47	3	G&M	-	-	-	391	375	364	54,593(3)	50,374
" " "	(Perkins) Fee A-1	1930	4,494,552	1,765,215		76	3	"	335	366	331	365	369	359	36,001	26,458
			91,221,308	46,239,511	44,981,797										388,710	479,273
[illegible]tural Gas Company	Sneed (Est.) 1-P	1932	3,049,[illegible]20	1,859,[illegible]77		39	6-T	T&NO	370	401	394	334	372	359	9,396	51,987
" " "	" 2-P	1932	10,296,484	5,823,137		19	"	"	-	353	344	343	327	324	17,372	27,134
" " "	J. T. Sneed 3-P	1935	4,998,520	4,015,200				McGeorge	352	341	333	327	320	315	17,261	18,870
" " "	" 4-P	1935	3,215,194	2,922,052		54	3	G&M	347	347	334	326	323	319	10,486	11,966
" " "	" 5-P	1935	3,696,390	3,637,551		7	B-12	D&P	371	374	347	339	331	329	18,282	12,662
" " "	" P-6	193[illegible]	4,107,249	4,107,249		38	6-T	T&NO	-	401	397	387	377	368	58,928	44,364
" " "	" 10-P	1937	937,742	937,742				Ragsdale	-	-	349	343	342	335	8,079(2)	5,433
" " "	" 11-P	1937	3,511,479	3,511,479		8	B-12	D&P	-	-	359	342	337	334	49,091(2)	27,311
" " "	" 13-P	1938	612,430	612,430		2	"	"	-	-	-	347	337	330	10,083(3)	10,268
" " "	" 14-SN	1939	1,264,281	1,264,281		22	6-T	T&NO	-	-	-	-	366	357	-	65,501
" " "	" 15-SN	1939	228,346	228,346		9	B-12	D&P	-	-	-	-	331	328	-	27,001
" " "	" 17-SN	1939	76,631	76,631		31	6-T	T&NO	-	-	-	-	373	362	-	13,178
" " "	" 19-SN	1939	324,304	324,304		6	B-12	D&P	-	-	-	-	327	322	-	25,390
" " "	" P-1	1936	3,443,155	3,443,155		35	6-T	T&NO	-	352	344	331	329	319	10,268(1)	10,082
" " "	" D-2 Sr	193[illegible]	676,948	676,948		26	"	"	3[illegible]1	398	398	395	383	368	11,904	9,765
			40,440,772	33,440,381	7,000,391										143,629	360,912
[illegible]Eastern Pipeline Co.	Sneed 1-23	1931	1,651,953	1,394,995		23	"	"	405	413	395	395	378	364	6,826	10,538
" " "	" 1-45	1931	1,441,875	1,151,01[illegible]		45	"	"	419	420	368	377	367	350	5,274	16,047
" " "	" 1-33	1932	2,055,731	1,691,146		33	"	"	417	-	395	-	375	359	5,581	16,865
" " "	" 1-28	1937	859,430	859,430		28	"	"	-	-	344	373	343	334	7,300(2)	17,332
" " "	" 1-43	1938	753,390	753,390		43	"	"	-	-	400	388	363	352	18,491(2)	26,825
" " "	" 1-44	1938	1,045,60[illegible]	1,045,60[illegible]		44	"	"	-	-	394	376	354	354	3,644(2)	30,155
" " "	" 1-25	1939	296,565	296,565		25	"	"	-	-	-	-	353	339	28,278(3)	28,366
" " "	" 1-27	1937	920,163	920,163		27	"	"	-	-	400	377	356	347	10,240(2)	26,142
" " "	Zoffness 1-55	1931	[illegible],352	1,162,[illegible]		55	"	"	413	409	395	399	378	364	16,386	11,567
" " "	" 2-55	1932	[illegible],297	[illegible],619,810		55	"	"	404	403	392	385	377	364	86,758	71,138
" " "	Masterson 1	1938	760,248	760,248		36	3	G&M	-	-	-	400	390	370	31,170(3)	29,179
			17,[illegible]	13,[illegible]	3,74[illegible],794										120,825	286,154
[illegible]il & Gas Company	J. T. Sneed 1	1937	1,733,769	1,733,769				John Griffin	-	-	389	384	377	367	26,527(2)	43,524
" " "	" 3	1938	2,185,[illegible]02	2,185,[illegible]02		47	6-T	T&NO	-	-	398	38[illegible]	378	368	131,869(2)	94,378
" " "	" 4	19[illegible]	571,409	571,409		39	"	"	-	-	388	383	373	362	10,987(2)	8,455
" " "	" [illegible]	1938	1,063,847	1,063,847		40	"	"	-	-	366	364	354	342	35,635(2)	31,459
" " "	" 7	1938	511,299	511,299		3	M-3	Grier	-	-	-	382	371	363	19,897(3)	16,881
" " "	" 8	1938	545,098	545,098		41	6-T	T&NO	-	-	-	373	356	342	31,645(3)	30,253
" " "	" 11	1939	448,[illegible]30	4[illegible]30		29	"	"	-	-	-	-	358	350	19,555(3)	17,818
" " "	" 12	1939	[illegible]	1[illegible]495		Tr.[illegible]		L. Johnson	-	-	-	-	306	304	-	26,781
" " "	" 13	1939	81,660	81,660		" 6		"	-	-	-	-	312	313	-	21,771
			7,288,109	7,288,109	0										0	293,320
[illegible]as Company	Shelton 1-A	19[illegible]	[illegible],966,[illegible]	3,2[illegible]68		52	[illegible]3	G&M	376	372	371	366	351	346	58,742	59,405
" "	" 2-A	19[illegible]	2,010,499	2,010,499		52	47	H&TC	-	-	-	373	366	357	18,656(3)	15,790
			[illegible],976,[illegible]	5,269,427	3,707,351										58,742	75,195
[illegible]tural Gas Company	Bivins 1-43	1936	988,560	988,560	0	93	46	H&TC	384	375	3[illegible]7	3[illegible]0	358	350	24,681	21,152
			16[illegible],339,197	106,900,904	59,438,293											

BASIC DATA ON QUADRANTS

IN WHICH THE CANADIAN RIVER GAS COMPANY LEASES ARE SITUATED

Name of Company (1)	Well Name and Number (2)		Year of First Withdrawals (3)	Total Metered Gas All Time To August 1, 1939 (4)	Total Gas Metered August 1, 1935 To August 1, 1939 (5)	Metered Gas Prior to August 1, 1935 (6)	Location Sec. (7)	Block (8)	Survey (9)	Pressures* 1935 (10)	1936 (11)	1937 (12)	1938 (13)
ian River Gas Company	T. Thompson	A-1	1929	3,482,844	1,595,223		24	26	ELRR	391	406	393	374
" " "	"	A-2	1930	2,495,376	1,272,027		19	44	H&TC	408	406	393	383
" " "	"	B-1	1929	2,048,145	625,460		22	26	ELRR	363	-	-	362
" " "	"	B-2	1936	3,744,453	3,744,453		17	44	H&TC	-	407	385	383
" " "	Sneed	1-A	1927	6,544,125	4,274,587		51	6-T	T&NO	416	408	392	390
" " "	"	1-B	1930	3,904,332	2,223,007		58	"	"	405	407	391	386
" " "	Crawford	1-A	1929	2,067,755	1,174,622		26	P.Mc	ELRR	419	417	413	413
" " "	Masterson	J-1	1928	5,302,697	3,256,560		59	0-18	D&P	406	383	-	409
" " "	Bivins	A-21	1938	5,641,847	5,641,847		33	P.Mc	ELRR	-	-	-	391
Total				35,231,574	23,307,786	11,423,788							
a Natural Gas Company	Coon-Sneed	2-M	1938	3,362,388	3,362,388		151	44	H&TC	-	-	-	376
" " "	Coon-Sneed	3-M	1938	630,674	630,674		17	6-T	T&NO	-	-	-	-
" " "	R. S. Coon	4-M	1932	3,857,795	2,728,930		103	44	H&TC	419	414	-	399
" " "	R. S. Coon	7-M	1937	2,183,290	2,183,290		102	"	"	-	413	407	398
" " "	R. S. Coon	11-M	1939	223,477	223,477		105	"	"	-	-	-	-
" " "	Killgore	2-G	1932	3,145,884	1,945,460		26	P.Mc	ELRR	-	400	405	400
" " "	Hass	1	1935	3,927,929	3,478,336		30	"	"	419	414	411	400
" " "	Sneed (Est.)	2-P	1936	1,073,275	1,073,275		19	6-T	T&NO	357	404	400	338
" " "	T. Thompson	1-P	1935	8,963,250	7,675,479		61	44	H&TC	414	403	398	388
" " "	"	2	1936	3,639,767	3,639,767		62	"	"	-	401	350	3[illegible]1
" " "	"	3	1936	2,280,247	2,280,247		60	"	"	-	403	395	388
" " "	"	4	1937	3,160,657	3,160,657		21	"	"	-	-	395	385
" " "	"	5	1939	1,613,684	1,613,684		20	"	"	-	-	-	-
" " "	"	6	1939	445,745	445,745		[illegible]	"	"	-	-	-	-
" " "	"	7	1939	120,021	120,021		50	"	"	-	-	-	-
" " "	Johnson	1-P	1938	4,019,551	4,019,551		2[illegible]	P.Mc	ELRR	-	-	-	401
Total				42,647,634	37,580,981	5,066,653							
rock Oil & Gas Company	A. Sneed	1	1938	944,513	944,513		32	6-T	T&NO	-	-	392	383
" " "	"	2	1938	1,539,018	1,539,018		21	"	"	-	-	395	383
" " "	Thompson	1	1937	1,571,695	1,571,695		23	44	H&TC	-	-	386	383
" " "	J. T. Sneed	2	1937	1,087,178	1,087,178		50	6-T	T&NO	-	-	395	385
" " "	Thompson	2	1937	1,051,064	1,051,064		21	26	ELRR	-	-	396	386
" " "	J. T. Sneed	6	1938	872,362	872,362		48	6-T	T&NO	-	-	-	386
" " "	"	10	1938	1,177,541	1,177,541		49	"	"	-	-	-	386
" " "	Heild	1	1937	1,794,499	1,794,499		20	26	ELRR	-	-	382	377
Total				10,068,370	10,068,370	0							
andle Eastern Pipeline Co.	J. T. Sneed	1-6	1932	1,145,362	831,998		[illegible]	B-10	ELRR	41[illegible]	413	404	395
" " "	"	1-48	1931	1,929,489	1,417,398		48	6-T	T&NO	413	410	394	394
" " "	T. Thompson	1-63	1937	1,343,611	1,343,611		63	44	H&TC	-	401	400	400
" " "	Brown	1-22	1936	2,842,782	2,842,782		22	44	"	411	-	39[illegible]	392
" " "	"	1-36	1937	1,951,504	1,951,504		36	6-T	T&NO	-	402	395	390
" " "	Thompson	1-25	1938	696,972	696,972		25	44	H&TC	-	-	-	380
" " "	Heild	1	1938	1,624,478	1,624,478		18	"	"	-	-	-	380
Total				11,544,198	10,718,743	825,455							
TOTAL				99,511,776	83,195,880	16,315,896							

1936 marked (1) First pressure and potential.
1937 " (2) " " " "
1938 " (3) " " " "

Well head gauge closed in pressures from Texas Railroad Commission official records.
Well potentials (open flow) from Texas Railroad Commission official records.
All volumes of gas in MCF. Prior to August 1, 1935 pressure base unknown. Subsequent to August 1, 1935 all gas on a pressure base of 14.65 lbs. per sq. in. absolute.

Exhibit No. 294

BASIC DATA OF QUADRANTS

IN WHICH THE CANADIAN RIVER GAS COMPANY LEASES ARE SITUATED

Quadrant No. 2
Moore County

	Year of First Withdrawals (3)	Total Metered Gas All Time To August 1, 1939 (4)	Total Gas Metered August 1, 1935 To August 1, 1939 (5)	Metered Gas Prior to August 1, 1935 (6)	Location Sec. (7)	Location Block (8)	Location Survey (9)	Pressures* 1935 (10)	Pressures* 1936 (11)	Pressures* 1937 (12)	Pressures* 1938 (13)	Pressures* 1939 (14)	Pressures* 1940 (15)	1935** Potential MCF (16)	1939** Potential MCF (17)
-1	1929	3,482,844	1,595,223		24	26	ELRR	391	406	393	374	366	353	68,932	60,410
-2	1930	2,495,376	1,272,027		19	44	H&TC	408	406	393	383	373	362	88,624	84,286
-1	1929	2,048,145	625,460		22	26	ELRR	363	-	-	362	362	364	3,853	1,201
-2	1936	3,744,453	3,744,453		17	44	H&TC	-	407	385	383	352	349	54,579(1)	35,991
-A	1927	6,544,125	4,274,587		51	6-T	T&NO	410	408	392	390	378	368	30,995	26,262
-B	1930	3,904,332	2,223,007		58	"	"	405	407	391	386	381	366	36,006	28,686
-A	1929	2,067,755	1,174,622		26	P.Mc	ELRR	419	417	413	413	404	396	11,016	9,907
-1	1928	5,302,697	3,256,560		59	O-18	D&P	406	383	-	409	367	363	11,692	9,454
-21	1938	5,641,847	5,641,847		33	P.Mc	ELRR	-	-	-	391	356	386	44,126(3)	48,771
		35,231,574	23,307,786	11,423,788										251,118	304,968
2-M	1938	3,362,388	3,362,388		151	44	H&TC	-	-	-	376	410	352	41,163(3)	29,800
3-M	1938	630,674	630,674		17	6-T	T&NO	-	-	-	-	362	355	-	6,317
4-M	1932	3,857,795	2,728,930		103	44	H&TC	419	414	-	399	387	377	6,583	11,217
7-M	1937	2,183,290	2,183,290		102	"	"	-	413	407	398	386	377	16,518(1)	12,779
1-A	1939	223,477	223,477		105	"	"	-	-	-	-	386	373	-	6,195
2-G	1932	3,145,884	1,945,460		26	P.Mc	ELRR	-	400	405	400	373	373	10,293	29,878
1	1935	3,827,929	3,478,336		30	"	"	419	414	411	400	391	391	51,875	44,726
2-P	1936	1,073,275	1,073,275		19	6-T	T&NO	357	404	400	338	376	362	17,372	11,727
1-P	1935	8,963,250	7,675,479		61	44	H&TC	414	403	398	388	377	368	37,584	23,362
2	1936	3,639,767	3,639,767		62	"	"	-	401	358	3[illegible]1	355	348	29,844(1)	24,035
3	1936	2,280,247	2,280,247		60	"	"	-	403	39[illegible]	388	379	368	17,205(1)	13,799
4	1937	3,160,657	3,160,657		24	"	"	-	-	398	385	374	366	14,820(2)	14,421
5	1939	1,613,684	1,613,684		20	"	"	-	-	-	-	366	366	-	87,044
6	1939	445,745	445,745		[illegible]	"	"	-	-	-	-	383	372	-	49,948
7	1939	120,021	120,021		59	"	"	-	-	-	-	358	339	-	42,384
1-P	1938	4,019,551	4,019,551		2[illegible]	P.Mc	ELRR	-	-	-	401	393	385	63,617(3)	65,789
		42,647,634	37,580,981	5,066,653										123,707	473,421
1	1938	944,513	944,513		32	6-T	T&NO	-	-	392	383	372	359	32,294(2)	30,150
2	1938	1,539,018	1,539,018		21	"	"	-	-	395	383	370	358	31,830(2)	75,705
1	1937	1,571,695	1,571,695		23	44	H&TC	-	-	386	383	371	364	12,228(2)	36,192
2	1937	1,087,178	1,087,178		50	6-T	T&NO	-	-	395	385	376	367	45,936(2)	41,482
2	1937	1,051,064	1,051,064		21	26	ELRR	-	-	396	386	376	368	26,540(2)	20,602
6	1938	872,862	872,862		48	6-T	T&NO	-	-	-	386	377	368	84,448(3)	83,334
10	1938	1,177,541	1,177,541		49	"	"	-	-	-	386	376	367	134,987(3)	120,376
1	1937	1,794,499	1,794,499		20	26	ELRR	-	-	382	377	367	366	58,360(2)	53,486
		10,083,370	10,068,370	0										0	461,337
1-6	1932	1,145,362	831,998		6	B-10	ELRR	414	413	404	395	378	372	6,931	7,875
1-48	1931	1,929,489	1,417,398		48	6-T	T&NO	413	410	394	394	377	365	13,392	25,667
1-63	1937	1,343,611	1,343,611		63	44	H&TC	-	401	400	400	385	374	27,028(1)	11,136
1-22	1936	2,842,782	2,842,782		22	44	"	411	-	396	392	377	363	53,759	34,674
1-36	1937	1,961,504	1,961,504		36	6-T	T&NO	-	402	395	390	377	362	53,731(1)	32,756
1-25	1938	696,972	696,972		25	44	H&TC	-	-	-	380	378	360	-	22,502
1	1938	1,624,478	1,624,478		18	"	"	-	-	-	380	367	360	-	53,486
		11,544,198	10,718,743	825,455										74,112	188,096
		99,511,776	83,195,880	16,315,896											

exas Railroad Commission official records.
lroad Commission official records.
gust 1, 1935 pressure base unknown. Subsequent to August 1, 1935
. per sq. in. absolute.

1936 marked (1) First pressure and potential.
1937 " (2) " " " "
1938 " (3) " " " "

Exhibit No. 294

BASIC DATA ON QUADRANTS

IN WHICH THE CANADIAN RIVER GAS COMPANY LEASES ARE SITUATED

Quadrant No. 3
Hutchinson County

Name of Company	Well Name and Number	Year of First Withdrawals	Total Metered Gas All Time To August 1, 1939	Total Gas Metered August 1, 1935 To August 1, 1939	Metered Gas Prior to August 1, 1935	Location Sec.	Location Block	Location Survey	Pressures* 1935	1936	1937	1938	1939	1940	1935** Potential MCF	1939** Potential MCF
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)
Canadian River Gas Company	Bivins B-1	1925	12,025,697	1,571,821		43	3	G&M	367	365	360	365	349	341	36,084	34,291
" " " "	" B-2	1926	6,486,331	148,471		90	46	H&TC	325	318	313	312	308	303	40,690	37,595
" " " "	" B-4	1929	10,131,979	1,378,227		13	Y-2	TTRR	-	352	-	348	-	333	43,152	-
" " " "	" B-5	1929	3,174,719	79,913		88	46	H&TC	242	246	247	244	243	241	13,725	14,216
" " " "	" B-6	1929	11,659,623	1,373,985		90	46	H&TC	350	345	340	337	335	326	44,960	37,351
" " " "	Johnson 1	1924	2,703,748	789,628		4	Y-2	TTRR	345	335	322	319	311	302	6,664	5,369
" " " "	Dunaway A-1	1930	1,619,592	297,112		5	Y-2	TTRR	356	346	342	339	334	326	32,607	26,827
" " " "	Bost A-1	1931	1,721,975	98,397		6	Y-2	TTRR	355	351	344	341	335	329	26,012	21,101
" " " "	" B-1	1931	1,297,061	384,987		9	Y-2	TTRR	356	361	353	346	345	338	11,107	5,039
" " " "	" C-1	1932	1,225,775	403,377		10	Y-2	TTRR	360	358	353	345	342	335	12,116	11,058
" " " "	Bivins F-1	1932	3,434,632	1,050,139		13	Y-2	TTRR	371	368	363	357	350	346	22,927	22,503
" " " "	Dunaway B-1	1932	1,674,924	161,082		5	Y-2	TTRR	316	313	310	311	303	295	21,725	18,451
" " " "	" A-2	1933	229,082	135,613		5	Y-2	TTRR	342	336	328	328	324	318	28,397	20,921
Total			57,385,138	7,872,757	49,512,381										340,166	254,722
Phillips Petroleum Company	Sanford (McMillan) 1	1928	2,151,288	1,400,821		82	46	H&TC	193	202	209	215	216	216	15,674	13,405
" " "	N.H. Johnson 1	1930	2,139,863	436,210		3	1	B&B	-	-	250	241	236	232	1,734(2)	1,757
" " "	Sanford 1	1928	11,390,001	6,324,438		82	46	H&TC	195	-	208	208	213	-	27,450	15,300
	(Operators - Continental)															
" " "	Land 1	1933	3,395,671	803,726		83	46	H&TC	-	-	-	213	217	219	12,621(3)	8,800
" " "	" 2	1933	16,149,515	3,683,051		83	46	H&TC	-	-	-	213	212	219	65,628(3)	60,845
" " "	Clair 1	1932	1,584,463	671,727		Tract #1, Tomlinson Survey			346	343	349	349	342	336	2,963	2,750
" " "	Operators 2	1932	4,224,676	1,650,667		82	46	H&TC	165	201	205	204	221	-	5,532	5,130
" " "	McMann 1	1932	7,730,903	837,840		83	46	H&TC	-	-	-	214	217	219	18,653(3)	20,300
" " "	" 2	1932	3,349,138	632,297		83	46	H&TC	-	-	-	217	222	221	8,575(3)	7,800
" " "	Bivins 1	1932	2,265,875	599,200		84	46	H&TC	189	211	218	221	222	222	8,086	10,156
" " "	Pool 2	1933	4,747,762	1,085,786		82	46	H&TC	-	-	-	211	217	218	14,384(3)	13,500
" " "	Pool 1	1934	2,597,499	746,102		82	46	H&TC	-	-	-	211	-	218	10,015(3)	8,700
" " "	Otis 1	1933	3,382,114	1,291,730		82	46	H&TC	132	199	206	210	215	215	13,646	15,000
" " "	Jay 1	1935	5,195,814	2,695,001		40	47	H&TC	-	219	220	223	224	223	15,305	9,200
" " "	Sanford 1	1934	3,794,849	2,147,434		1	1	B&B	-	271	265	261	253	250	14,338	5,900
" " "	Yantes 1	1935	2,448,746	586,557		8	Y-2	TTRR	227	263	264	269	248	245	16,043	8,390
" " "	Williams 1	1934	4,342,038	2,254,322		43	47	H&TC	-	-	253	247	239	234	10,486(2)	7,700
" " "	Andorf 1	1935	862,479	673,980		80	46	H&TC	212	205	210	211	212	213	2,728	3,730
" " "	Yake 2	1934	3,617,096	2,173,221		36	47	H&TC	207	209	211	217	217	213	17,425	9,800
" " "	" 3	1935	413,989	268,284		36	47	H&TC	204	198	212	218	215	-	2,176	1,988
" " "	Mudget 1	1933	1,589,258	552,695		85	46	H&TC	200	230	235	230	232	228	6,200	4,770
" " "	Yake 4	1936	2,131	2,131		36	47	H&TC	215	-	-	-	-	-	-	-
" " "	" 5	1936	2,545,985	2,545,985		35	47	H&TC	-	215	214	230	217	214	25,826	2,050
" " "	E. Williams 1	1936	3,205,067	3,205,067		42	47	H&TC	-	243	247	251	237	233	22,828	4,770
" " "	Burl 1	1934	1,622,965	787,815		4	1	B&B	250	240	236	235	232	226	10,082	8,983
" " "	Cecil 1	1933	737,045	285,110		85	46	H&TC	212	230	235	230	-	-	3,270	-
" " "	Eagle 1	1933	944,414	659,729		86	46	H&TC	-	231	232	232	231	228	9,474	11,880
" " "	Addy 1	1936	1,490,345	1,490,345		3	1	B&B	-	-	271	271	259	247	11,220(2)	10,345
" " "	Fromma 1	1936	736,116	736,115		2	1	B&B	-	302	296	287	275	262	24,500	8,140
" " "	Hopp 1	1936	587,330	587,330		15	X0½	HO&B	-	256	253	251	242	232	11,687	4,490
" " "	Cattle 1	1936	2,257,609	2,257,609		2	B	BS&F	-	265	260	258	248	244	13,363	7,000
" " "	Chapp 2	1934	744,717	357,265		78	46	H&TC	200	186	-	195	204	208	1,199	2,630
" " "	Johnson 1	1934	208,991	207,064		1	in	E.Tomlinson	-	325	303	306	291	285	2,369	2,626
" " "	Snow 1	1937	898,103	898,103		44	47	H&TC	-	-	271	265	248	241	22,922(2)	19,758
" " "	Snow 2	1937	850,138	850,138		45	47	H&TC	-	-	279	270	-	254	19,106(2)	14,988
" " "	Wild Bill 1	1937	456,983	456,983		53	47	H&TC	-	251	292	317	-	276	12,950	-
						(E.Sikes)										
" " "	Otis 2	1933	1,430,825	796,492		82	46	H&TC	191	195	207	214	215	216	7,460	3,000
" " "	Glass 1	1933	2,905,331	1,344,571		80	46	H&TC	188	197	199	204	204	213	7,073	1,800
" " "	Chapp 3	1934	1,199,915	580,029		78	46	H&TC	201	189	-	196	207	214	2,560	16,300
" " "	Cecil 2	1933	725,884	3,379		85	46	H&TC	210	-	-	-	-	-	5,190	Dead
" " "	M. Byrd 1	1934	1,301,685	1,228,091		SW/4 D. Luce Survey			-	-	311	298	281	270	5,669(2)	3,800
" " "	Yake 6	1938	331,582	331,582		35	47	H&TC	-	-	-	218	215	215	5,902(3)	5,100
" " "	B. Redord 1	1937	882,226	882,226		4	Y-2	J.Poitevent	-	-	302	293	276	274	10,151(2)	6,095
" " "	Snow 3	1937	931,987	931,987		58	M-23	TCRR	-	-	274	266	-	273	25,854(2)	-
Total			114,770,461	52,946,236	61,824,225										384,988	376,446

This is the best this can be photographed because it is very tightly bound.

Exhibit No. 294

BASIC DATA ON QUADRANTS

IN WHICH THE CANADIAN RIVER GAS COMPANY LEASES ARE SITUATED

Quadrant No. 3
Hutchinson County

me of Company (1)	Well Name and Number (2)	Year of First Withdrawals (3)	Total Metered as all Time To August 1, 1939 (4)	Total Gas Metered August 1, 1935 To August 1, 1939 (5)	Metered Gas Prior to August 1, 1935 (6)	Location Sec. (7)	Location Block (8)	Location Survey (9)	Pressures* 1935 (10)	1936 (11)	1937 (12)	1938 (13)	1939 (14)	1940 (15)	1935** Potential MCF (16)	1939** Potential MCF (17)
rporation	Sanford C-1	1933	5,1[illegible],951	[illegible],673,688		79	46	H&TC	201	200	205	209	214	215	29,683	15,400
"	Crudgington 1	1933	2,526,[illegible]18	1,131,391		7	Y-2	TTRR	300	324	292	294	303	303	21,855	17,506
"	Sanford 1	1927	6,567,361	4,105,550		80	46	H&TC	187	200	205	208	213	217	27,660	19,600
"	" 1-A	1931	6,564,157	2,013,162		73	46	H&TC	192	190	200	-	210	210	13,587	7,800
"	" B-1	1931	[illegible],957,375	2,129,196		81	46	H&TC	190	199	204	-	216	219	12,866	9,600
"	Dunaway A-1	1934	1,251,409	842,825		7	Y-2	TTRR	300	305	324	305	297	297	10,983	10,050
"	" 2	1936	695,434	695,434		5	Y-2	TTRR	314	324	326	314	313	313	22,437	9,960
"	Herring 3	1937	1,159,752	1,159,752		7	J	H&GN	-	-	334	318	315	291	31,532(2)	5,090
"	" 1	1937	1,185,822	1,185,822		6	J	H&GN	-	-	333	314	292	230	29,780(2)	3,550
"	" 4	1937	1,049,492	1,049,492		7	J	H&GN	-	-	348	332	308	288	33,192(2)	3,630
"	" 7	1936	951,837	951,837		8	J	H&GN	-	-	-	384	313	285	12,908(3)	4,400
"	" 8	1939	131,008	131,008		G. D. Luce Survey			-	-	-	-	300	277	-	3,730
"	" 9	1937	208,664	208,664		" "	"	"	-	-	-	-	313	293	-	9,500
"	" 10	1936	116,081	116,081		" "	"	"	-	-	-	-	325	305	-	3,800
"	River Bed 3	1938	661,282	661,282		79	46	H&TC	-	-	-	209	212	212	10,355(3)	7,400
	Texas Herring 1	1939	531,008	531,008		8	J	H&GN	-	-	-	-	302	269	-	2,860
tal			39,773,642	21,608,282	18,164,[illegible]										139,071	139,756
	Sanford F-1-G	1927	523,[illegible]74	351,567		[illegible]	X03	HO&B	-	-	-	200	211	215	5,750(3)	4,600
estate	Bivins 1	1929	1[illegible],[illegible]65,[illegible]	3,794,245	0	91	46	H&TC	362	358	-	350	3[illegible]	339	30,733	24,054
	Sanford 2	1931	13,240	0		87	46	H&TC	Cannot identify wells in T.R.R.C. report - no production recorded since 1935.							
ental	Heimer 1	1947	73,346	0		82	46	H&TC				De				
ir-Prairie	Merchant 1	1930	8,656,256	3,202,215		37	47	H&TC	207	206	221	220	217	214	31,277	28,300
	Sanford 1	1931	11,365,436	2,193,021		82	46	H&TC	-	200	210	208	216	220	18,733	2,450
t-Gulf	Sanford 1-A	1930	616,987	581,352		8[illegible]	46	H&TC	-	200	207	210	213	216	8,477	15,091
t (New Phillips)	Ingerton 1-A	1929	5,501,502	4,726,932		41	47	H&TC	210	250	232	-	231	230	19,949	18,500
t	Byrd 1	1930	1,917,219	1,605,613		SA/C D. Luce Survey			-	352	328	323	302	283	11,299	4,900
t (New Phillips)	Ingerton A-2	1930	1,385,800	1,381,129		41	47	H&TC	247	240	232	-	231	230	8,723	3,500
" "	" 1-B	1936	1,444,392	1,444,392		327	2	TC&R	-	242	235	-	237	232	12,249	2,200
	Sanford 2-B	1932	2,112,390	2,090,065		81	46	H&TC	-	199	206	213	216	215	15,549	14,800
il Company	Johnson A-1	1933	2,178,902	298,814		1	X03	HAOB	-	-	-	211	206	210	3,453(3)	2,790
ir-Prairie	C. Merchant 2	1933	6,021,316	1,825,839		37	47	H&TC	254	178	220	221	219	215	17,260	13,300
"	Reed 1	1930	2,983,519	605,943		Center SW McDonald Survey			296	290	-	281	272	260	10,475	8,181
il Company	Johnson 1-B	1933	1,631,342	277,693		NE Gammell Survey			-	-	-	205	180	217	1,018(3)	545
" "	" 1-F	1934	2,376,374	619,548		15	X03	HO&B	255	235	241	234	231	221	5,149	6,047
ie	Sanford 1	1933	4,326,249	1,419,6[illegible]		82	46	H&TC	191	202	208	213	216	216	12,210	9,400
se	Sanford 1	1933	6,734,303	1,607,508		83	46	H&TC	-	-	-	210	224	-	23,495(3)	15,800
	Bivins 1	1934	164,773	21,678		86	46	H&TC	-	245	235	150	175(BH)	175	983	1,578(BH)
ubin	Rubin 2	1934	2,687,977	158,434		81	46	H&TC	-	-	-	224	218	-	5,615(3)	4,980
ir-Prairie	C. Merchant 1	1933	748,884	366,308		37	47	H&TC	262	210	175	165	-	-	2,032	-
"	" " 3	1933	1,233,643	656,638		37	47	H&TC	266	223	213	212	220	232	3,097	1,704
"	" " V-3	1934	86[illegible],90[illegible]	479,573		37	47	H&TC	257	225	201	192	220	172	2,318	2,125
"	" " V-4	1935	775,909	615,616		37	47	H&TC	255	221	-	219	221	236	1,905	1,530
illiams	Sanford 1	1933	10,014,345	3,630,6[illegible]		30	46	H&TC	190	190	-	205	209	213	20,165	16,387
ubin	Rubin 3	193[illegible]	5,641,787	1,543,931		85	46	H&TC	19[illegible]	226	236	-	223	229	19,435	31,358
"	" 4	1934	6,829,316	1,502,678		85	46	H&TC	190	232	230	-	223	220	20,137	6,334
Deal	Sanford 1	1933	14,498,926	6,898,746		81	46	H&TC	-	200	212	210	220	-	39,048	46,000
"	" 2	1934	772,176	78,033		81	46	H&TC	Nothing in Texas R. R. Commission report							
il	Jameson 1	1936	547,487	547,457		A. Dubois Survey			350	-	290	281	275	271	4,748	1,450
ol	Johnson 1	1933	1,861,251	472,100		1	X03	HO&B	-	-	-	215	213	214	3,453(3)	3,010
t (New Phillip	Ingerton C-1	1937	87[illegible],474	978,474		1	"	BS&F	-	-	287	285	267	261	14,819(2)	13,360
ir-Prairie	Johnson D-1	1935	1,281,654	803,573		8	Y-2	TTRR	210	232	264	261	237	241	21,105	8,753
	1	1933	3,421,854	1,164,320		84	46	H&TC	-	-	-	218	223	223	12,899(3)	12,200
	-Herring 2	1937	732,291	732,291		SA/L Watts Survey			-	-	323	295	275	255	12,355(2)	5,730
	" Merchant,Cal. 1	1937	534,482	534,482		39	47	H&TC	-	-	-	235	239	225	16,358(3)	11,600
	" -Herring 3	1937	758,288	758,288		5	J	H&GN	-	-	335	310	285	248	11,802(2)	3,360
lind	Merchant 2	1934	108,812	51,147		38	47	H&TC	143	-	-	178	176(BH)	176	-	139(BH)
	" 3	1934	42,615	15,002		38	47	H&TC	-	-	-	165	163(BH)	163	-	192
ls	Sanford 1	1938	81,185	81,185		78	46	H&TC	-	175	201	-	-	-	50(1)	-
	" 1	1934	4,400,325	1,283,637		83	46	H&TC	-	-	-	216	221	-	18,149(3)	11,200
	" 2	1933	13,629,850	2,226,634		83	46	H&TC	-	-	-	211	221	-	32,468(3)	33,000
ir-Prairie	Merchant V-5	1938	675,401	675,401		37	47	H&TC	-	-	-	217	223	215	32,970(3)	26,500
y-Cabot	Herring B-1	1938	671,936	671,936		3	J	H&GN	-	-	326	295	241	236	24,156(1)	3,340
"	Yake A-1	1937	622,610	622,610		2	J	H&GN	-	-	300	294	257	245	9,397(2)	3,440
"	" B-1	1937	700,093	700,083		1	J	H&GN	-	-	290	292	263	243	23,134(2)	13,600
"	" C-1	1937	736,536	786,536		4	J	H&GN	-	-	316	295	-	-	17,205(2)	-
lind	Merchant 4	1937	349,094	349,094		38	47	H&TC	-	-	-	210	212	208	5,364(3)	4,000
ation-Danube	Wheatley 1	1934	10,092,077	2,393,737		2	Y-2	TTRR	-	-	-	337	331	313	38,512	28,768
Total			197,210,963	59,544,953	97,665,910										336,915	470,096

BASIC DATA ON QUADRANTS

IN WHICH THE CANADIAN RIVER GAS COMPANY LEASES ARE SITUATED

Name of Company (1)	Well Name and Number (2)	Year of First Withdrawals (3)	Total Metered Gas All Time To August 1, 1939 (4)	Total Gas Metered August 1, 1935 To August 1, 1939 (5)	Metered Gas Prior to August 1, 1935 (6)	Location Sec. (7)	Location Block (8)	Location Survey (9)	1935 (10)	1936 (11)
rson (N.A.)	Sanford 1	1934	6,979,831	2,454,215		85	46	H&TC	210	230
rson-Antelope	" 4	1933	3,199,541	568,694		82	46	H&TC	-	194
rson-Alamosa	" B-5	1935	5,054,382	2,942,191		85	46	H&TC	205	232
rson-Antelope	" 1	1932	450,479	164,893		82	46	H&TC	-	-
"	" 3	1932	1,511,411	472,422		82	46	H&TC	-	198
"	" 2	1932	2,486,445	763,072		82	46	H&TC	-	205
rson-Alamosa	" 1	1933	2,685,908	884,682		82	46	H&TC	172	201
"	" 2	1933	3,177,227	753,907		83	46	H&TC	-	203
"	" 3	1933	4,196,665	890,650		83	46	H&TC	137	208
	" 4	1933	4,175,644	1,413,062		85	46	H&TC	193	213
rson-Great Plains	" 1	1933	9,410,458	4,156,836		87	46	H&TC	230	240
rson	Whittenberg 2	1934	4,055,373	1,447,723		1	Yantis Survey		-	208
rson-Continental	" 1	1934	5,880,088	2,577,633		1	Yantis Survey		205	205
Total			53,263,502	19,494,980	33,768,522					
[illegible]	Cart.Johnson 1-P	1931	2,040,450	723,722		1	Y-2	TTRR	348	342
	Deahl 1-E	1938	258,474	258,474		3	3	AB&M	-	-
	Johnson 1	1934	1,714,724	843,941		2	Y-2	TTRR	348	338
	" A-1-G		3,662,264	1,528,200		1	Y-2	TTRR	351	346
mount	Sanford 1	1934	2,507,450	1,237,143		82	46	H&TC	163	12[illegible]
	" 2	1933	12,896,466	7,797,713		82	46	H&TC	190	202
	" 3	1933	9,781,521	4,997,720		82	46	H&TC	-	-
Total			32,861,349	17,386,913	15,474,436					
andle Eastern	Bost 1-9	1931	2,190,365	1,098,282		9	Y-2	TTRR	355	349
" "	" 1-14	1931	1,993,435	995,419		14	Y-2	TTRR	37[illegible]	36[illegible]
" "	Bivins 1-91	1931	845,955	467,559		91	46	H&TC	326	313
	Sanford 1	1932	8,782,320	2,125,329		93	46	H&TC	-	-
Total			13,812,075	4,646,599	9,165,476					
GRAND TOTAL			469,077,030	183,496,680	285,580,350					
Less Repressure Gas				11,046,772						
				172,449,908						

Well head gauge closed in pressures from Texas Railroad Commission official records.
Well potentials (open flow) from Texas Railroad Commission official records.
Wells probably have been transferred to some other company - do not have any record; therefore, cannot identify well in Texas Railroad Commission report.

: All volumes of gas in MCF. Prior to August 1, 1935, pressure base unknown. Subsequent to August 1, 1935, all gas on a pressure base of 14.65 lbs. per sq. in. absolute.

marked (1) First pressure and potential.
" (2) " " "
" (3) " " "

Exhibit No. 294

BASIC DATA ON QUADRANTS

IN WHICH THE CANADIAN RIVER GAS COMPANY LEASES ARE SITUATED

Quadrant No. 3
Hutchinson County

Year of First Withdrawals (3)	Total Metered Gas All Time To August 1, 1939 (4)	Total Gas Metered August 1, 1935 To August 1, 1939 (5)	Metered Gas Prior to August 1, 1935 (6)	Location Sec. (7)	Location Block (8)	Location Survey (9)	Pressures* 1935 (10)	Pressures* 1936 (11)	Pressures* 1937 (12)	Pressures* 1938 (13)	Pressures* 1939 (14)	Pressures* 1940 (15)	1935** Potential MCF (16)	1939** Potential MCF (17)
1934	6,979,831	2,454,215		85	46	H&TC	210	230	232	213	230	233	13,006	13,968
1933	3,199,541	568,694		82	46	H&TC	-	194	208	208	224	-	7,885(1)	6,800
1935	5,054,382	2,942,191		85	46	H&TC	205	232	220	231	222	202	30,334	10,383
1932	450,479	164,893		82	46	H&TC	-	-	-	198	211	213	2,619(2)	1,787
1932	1,511,411	472,422		82	46	H&TC	-	198	-	204	210	-	1,982	4,540
1932	2,486,445	763,072		82	46	H&TC	-	205	196	202	-	-	5,891	-
1933	2,685,908	884,682		82	46	H&TC	172	201	210	225	-	-	5,513	-
1933	3,177,227	753,907		83	46	H&TC	-	203	-	222	204	-	8,492	5,400
1933	4,196,665	890,650		83	46	H&TC	137	208	-	220	222	-	11,376	10,500
1933	4,175,644	1,413,062		85	46	H&TC	193	213	226	224	220	221	8,344	6,301
1933	9,410,458	4,156,836		87	46	H&TC	230	240	240	239	237	237	27,039	27,010
1934	4,055,373	1,447,723		1	Yantis Survey		-	208	220	218	220	-	14,940(1)	6,334
1934	5,880,088	2,577,633		1	Yantis Survey		205	205	227	224	221	231	11,853	6,638
	53,263,502	19,494,980	33,768,522										123,830	99,661
1931	2,040,450	723,722		1	Y-2	TTRR	348	342	339	335	328	321	11,600	11,955
1938	258,474	258,474		3	3	AB&M	-	-	-	339	330	322	8,858(3)	8,612
1934	1,714,724	843,941		2	Y-2	TTRR	348	338	335	331	323	316	11,994	10,159
	3,662,264	1,528,200		1	Y-2	TTRR	351	346	343	339	331	323	15,962	14,657
1934	2,507,450	1,237,143		82	46	H&TC	163	125	205	204	***	***	4,277	***
1933	12,896,466	7,797,713		82	46	H&TC	190	202	212	216	***	***	19,425	***
1933	9,781,521	4,997,720		82	46	H&TC	-	-	208	209	***	***	20,905(2)	***
	32,861,349	17,336,913	15,474,456										63,258	45,383
1931	2,190,365	1,093,282		9	Y-2	TTRR	355	349	340	345	336	327	30,128	19,004
1931	1,993,435	995,419		14	Y-2	TTRR	[illegible]	360	350	352	349	336	19,314	23,777
1931	845,955	467,559		91	46	H&TC	326	313	310	312	312	300	9,563	15,656
1932	8,782,320	2,125,329		93	46	H&TC	-	-	-	214	223	-	33,570(3)	24,900
	13,812,075	4,646,599	9,165,476										59,005	83,337
	469,077,030	183,496,030	285,580,310											
		11,046,772												
		172,449,908												

ilroad Commission official records.
ommission official records.
r company - do not have any record; therefore, cannot identify well in Texas Railroad Commission report.

35, pressure base unknown. Subsequent to August 1, 1935, all gas on a pressure base of 14.65 lbs. per sq. in. absolute.

BASIC DATA ON QUADRANTS

IN WHICH THE CANADIAN RIVER GAS COMPANY LEASES ARE SITUATED

Name of Company (1)	Well Name and Number (2)		Year of First Withdrawals (3)	Total Metered Gas All Time To August 1, 1939 (4)	Total Gas Metered August 1, 1935 To August 1, 1939 (5)	Metered Gas Prior to August 1, 1935 (6)	Location Sec. (7)	Block (8)	Survey (9)
an River Gas Company	Sanford	A-1	1930	4,219,082	3,292,789		11	3	AB&M
" " "	Bivins	B-3	1929	12,865,144	1,750,913		15	Y-2	TTRR
" " "	Poling	A-1	1929	3,367,999	83,057		12	Y-2	TTRR
" " "	Bost	C-2	1932	963,074	365,579		10	Y-2	TTRR
" " "	Bost	D-1	1932	697,539	567,844		1	2	H&GN
otal				22,112,838	6,060,182	16,052,656			
ver Gas Company	Deahl	1-A	1930	2,520,832	1,273,328		5	5	B&B
" " "	Bivins	A-3	1931	2,889,767	1,532,068		43	M-20	G&M
" " "	Bivins	A-4	1935	1,135,949	1,132,692		44	M-20	"
" " "	Bivins	A-5	1935	3,042,093	3,021,529		45	M-20	"
" " "	Deahl	1-B	1936	861,316	861,316		7	5	B&B
otal				10,449,957	7,820,933	2,629,024			
	Poling	1-A	1930	6,478,809	3,390,447		22	Y-2	TTRR
	Poling	3	1930	6,253,946	3,275,449		22	Y-2	TTRR
otal				12,732,755	6,665,896	6,066,859			
rn Natural	Poling	1	1932	2,137,201	1,658,106	479,095	24	Y-2	TTRR
Corporation	Chapman	1	1934	5,400,115	2,168,767	3,231,348	7	3	AB&M
dle Eastern Pipeline Co.	Sanford	1-12	1938	442,307	442,307		12	3	AB&M
" " "	"	1-13	1938	826,644	826,644		13	3	AB&M
" " "	"	1-14	1938	657,054	657,054		14	3	AB&M
" " "	"	1-16	1938	750,790	750,790		16	3	AB&M
otal				2,676,795	2,676,795	0			
Service	Fugua	3	1931	9,020,730	1,516,949		16	3	AB&M
"	"	4	1931	1,207,567	933,025		6	8	H&GN
"	"	1	1930	4,568,496	1,500,999		17	3	AB&M
"	"	2	1930	7,512,931	2,349,529		19	3	AB&M
"	"	5	1938	1,643,770	1,643,770		5	S	H&GN
"	"	6	1938	769,150	769,150		4	S	H&GN
"	"	7	1938	974,323	974,323		7	S	H&GN
"	Poling	1	1929	8,205,610	2,471,954		26	Y-2	TTRR
"	Bennett	1	1931	2,687,452	1,198,611		[illegible]	5	B&B
"	C. E. Deahl	1	1930	1,772,262	892,044		21	Y-2	[illegible]
"	"	2	1930	2,271,016	905,133		2	2	HGN
"	"	3	1930	16,112,596	9,986,024		23	Y-2	TTRR
"	O. W. Deahl	1	1930	4,069,961	1,596,597		3	5	B&B
"	"	2	1931	5,233,024	2,602,624		25	Y-2	TTRR
"	"	3	1936	6,580,143	6,580,143		15	3	AB&M
"	"	4	1937	1,671,940	1,671,940		20	3	AB&M
"	"	5	1937	1,486,961	1,486,961		4	5	B&B
"	"	6	1937	664,574	664,574		3	2	H&GN
"	"	7	1937	536,478	536,478		4	2	H&GN
"	"	8	1938	606,219	606,219		6	3	AB&M
"	Noel	1	1932	2,338,744	1,040,819		41	4	I&GN
al				78,933,997	42,227,866	36,706,131			
TAL				134,443,658	69,278,545	65,165,113			

head guage closed in pressures from Texas Railroad Commission official records.
potentials (open flow) from Texas Railroad Commission official records.
ll volumes of gas in MCF. Prior to August 1, 1935 pressure base unknown. Subsequent to August 1, 1935
ll gas on a pressure base of 14.65 lbs. per sq. in. absolute.

1936 marked (1) First
1937 " (2) "
1938 " (3) "

BASIC DATA ON QUADRANTS

IN WHICH THE CANADIAN RIVER GAS COMPANY LEASES ARE SITUATED

Exhibit No. 294

Quadrant No. 4
Carson County

Total Metered Gas All Time To August 1, 1939 (4)	Total Gas Metered August 1, 1935 To August 1, 1939 (5)	Metered Gas Prior to August 1, 1935 (6)	Location Sec. (7)	Location Block (8)	Location Survey (9)	Pressures* 1935 (10)	Pressures* 1936 (11)	Pressures* 1937 (12)	Pressures* 1938 (13)	Pressures* 1939 (14)	Pressures* 1940 (15)	1935** Potential MCF (16)	1939** Potential MCF (17)
4,219,082	3,292,789		11	3	AB&M	397	395	383	375	371	359	74,599	70,064
12,865,144	1,750,913		15	Y-2	TTRR	373	368	365	361	352	-	33,200	26,947
3,367,999	83,057		12	Y-2	TTRR	377	368	363	358	353	344	13,006	11,376
963,074	365,579		10	Y-2	TTRR	366	363	355	357	350	339	24,685	16,796
697,539	567,844		1	2	H&GN	357	334	346	346	340	333	12,662	8,664
22,112,838	6,060,182	16,052,656										158,152	133,847
2,520,832	1,273,328		5	5	B&B	403	399	393	385	372	369	9,672	7,549
2,889,767	1,532,068		43	M-20	G&M	405	401	395	388	379	-	23,940	17,875
1,135,949	1,132,692		44	M-20	"	408	402	396	389	380	-	17,826	12,975
3,042,093	3,021,529		45	M-20	"	408	403	399	-	-	-	32,678	-
861,316	861,316		7	5	B&B	-	402	395	388	378	365	11,100	8,680
10,449,957	7,820,933	2,629,024										95,216	47,079
6,478,809	3,390,417		22	Y-2	TTRR	405	-	382	382	373	371	13,536	12,213
6,253,946	3,275,479		22	Y-2	TTRR	400	-	384	382	375	71	15,279	15,300
12,732,755	6,665,896	6,066,859										28,815	27,513
2,137,201	1,658,106	479,095	24	Y-2	TTRR	417	401	392	386	377	369	16,403	11,401
5,400,115	2,168,767	3,231,348	7	3	AB&M	400	390	390	372	365	361	23,555	18,634
442,307	442,307		12	3	AB&M	-	-	-	385	375	364	17,279(3)	14,227
826,644	826,644		13	3	AB&M	-	-	-	381	377	366	36,297(3)	29,242
657,054	657,054		14	3	AB&M	-	-	-	-	379	369	-	36,182
750,790	750,790		16	3	AB&M	-	-	-	394	377	367	46,159(3)	21,896
2,676,795	2,676,795	0										0	101,547
8,020,730	1,516,949		18	3	AB&M	407	402	396	389	380	372	9,423	5,375
1,207,567	933,025		6	8	H&GN	403	394	397	387	380	372	4,319	2,939BH 764M
4,568,496	1,500,999		17	3	AB&M	405	399	393	388	382	370	11,625	8,137
7,512,981	2,349,529		19	3	AB&M	407	401	395	387	380	373	19,125	14,600
1,643,770	1,643,770		5	S	H&GN	-	-	395	386	377	372	20,787(2)	13,534
769,150	769,150		4	S	H&GN	-	-	-	383	377	374	8,565(3)	5,624
974,323	974,323		7	S	H&GN	-	-	-	391	383	375	8,139(3)	8,243
8,205,610	2,471,954		23	Y-2	TTRR	404	402	398	385	380	374	7,707	5,033
2,687,452	1,198,611		6	5	B&B	406	401	395	387	379	372	8,139	6,428
1,772,262	692,044		21	Y-2	I&GN	371	360	360	356	350	343	5,400	3,450
2,271,016	905,133		2	2	HGN	365	357	355	351	345	339	9,675	6,400
16,112,596	9,986,024		23	Y-2	TTRR	406	397	390	383	376	371	54,836	54,307
4,069,961	1,596,597		3	5	B&B	404	400	393	383	375	369	10,940	8,591
5,233,024	2,602,624		25	Y-2	TTRR	404	399	392	384	377	371	15,504	12,099
6,580,143	6,580,143		15	3	AB&M	-	401	395	387	379	373	46,457(1)	42,327
1,671,940	1,671,940		20	3	AB&M	-	399	394	386	378	371	13,800(2)	11,900
1,486,961	1,486,961		4	5	B&B	-	-	393	384	377	372	17,363(2)	12,264
664,574	664,574		3	2	H&GN	-	-	386	376	369	364	8,632(2)	6,250
536,478	536,478		4	2	H&GN	-	-	383	375	368	361	5,900(2)	5,200
606,219	606,219		6	3	AB&M	-	-	-	340	312	309	10,858(3)	8,563
2,338,744	1,040,819		41	4	I&GN	304	384	251	270	260	256	13,507	11,770
78,933,997	42,227,866	36,706,131										170,200	253,798
134,443,658	69,278,545	65,165,113											

...m official records.
...al records.
...ase unknown. Subsequent to August 1, 1935

1936 marked (1) First pressure and potential.
1937 " (2) " " " "
1938 " (3) " " " "

He explained Exhibit 294 as follows:

Going from left to right by columns, the first column gives the name of the Company, well name and the number, and the year of first withdrawals. It must be remembered, however, that these data and schedules are all based upon the period from August to August, rather than by calendar years. Column 4 shows the total gas metered from the beginning of production to August 1, 1939. Column 5 shows the total gas metered from August 1, 1935 to August 1, 1939. Column 6 shows the gas metered prior to August 1, 1935. Column 7 shows the section upon which the well is located. Column 8 shows the block number, and Column 9, the survey. Columns 10 to 15, inclusive, represent the pressures of the various wells listed from 1935 to 1940, inclusive. Column 16 shows the well potentials as of 1935. Column 17 shows the well potentials as of 1939. Statement 1 in the footnotes to the Exhibit refers to the first pressures and potentials that were recorded in 1935 and 1936. Statement 2 of the footnote refers to the potentials and pressures first recorded in 1937. Statement 3 in the footnote refers to the first pressures and potentials recorded in 1938. The pressure base was unknown prior to August 1, 1935, but subsequent to August 1, 1935, the volume of gas is shown on a pressure base of 14.65 lbs. per square inch absolute.

The witness then testified further with respect to Exhibit 294, as follows:

"Q. (Mr. March) I notice there is another footnote at the bottom. What is the significance of that?

"A. (Hammer) Well, the significance of that is this: I had no definite information and could secure no definite information on the pressure base prior to August 1, 1935 and that footnote was put in there to segregate the 1935-1939 data from that prior to 1935.

"Q. I believe you have heretofore made explanation in regard to that data prior to 1935, have you not?

"A. I have.

"Q. As I understand it, this exhibit contains all of the wells in the Canadian River Gas Company's quadrants?

"A. To the best of my knowledge and belief, it contains all of them, that is right. Those are all of the

wells upon which I could secure data up to August 1, 1939.

"Q. All of the gas wells?

"A. Yes.

"Q. Do you make any inspection (construction), interpretation or argument in regard to the significance of any of this data?

"A. No. None whatsoever. * * *" (P. 15569).

Hammer again testified as follows:

"Q. Mr. Hammer, do you make any constructions, interpretations or arguments as to the significance of the data contained in Exhibit number 295?

"A. None whatsoever." (P. 15572).

On Tuesday, March 21, Counsel for Canadian requested that cross examination be deferred on the exhibits until the recessed hearing in Washington. Mr. Marsh, Commission counsel, objected to this, his objection (Vol. 101, pp. 15574-15582) being as follows:

Mr. March: Now, Mr. Examiner, I would like to state for the record before cross examination of the witness by Mr. Keffer that I discussed the matter with Mr. Spencer, having given him the exhibit last Saturday. Arrangements between counsel was the cross examination would be had and the Examiner would act upon the exhibit with the understanding that after it is cross examined upon that a motion to strike would be in order.

In other words, if there are any errors contained therein, it can be brought to the attention of the Examiner.

The Trial Examiner: You mean by that, Mr. March, errors in calculations, for example?

Mr. March: There are no calculations there. In other words, the company will have a complete opportunity to check it to see if there are any errors in it. We don't think there will be but there may be.

The Trial Examiner: It just isn't clear to me, Mr. March, as to what you intend to do here.

Mr. March: This exhibit was handed to Mr. Spencer Saturday. The arrangement was for cross examination to be had upon this exhibit and if the Examiner admits it into

evidence, the motion will be reserved—there will be a reservation made to make a motion to strike when this has been thoroughly checked by counsel.

Mr. Keffer: I am wondering, Mr. March, if we wouldn't arrive at the same conclusion, if ruling is just suspended on it until later.

Mr. March: We object to that. That is not the arrangement at all.

Mr. Keffer: Please let me finish, Mr. March, and then you can talk all you want to.

I understand in substance that the agreement was made between Mr. Spencer and Mr. March, as Mr. March has just stated, and I am not going back on any agreement. What I am getting to is the cross examination of this witness. I didn't understand that that was a part of the agreement. I don't know that it will even be necessary after this exhibit is checked, but, obviously, you can see by looking at either one of the exhibits that it will take almost as long to check it as it took Mr. Hammer to make it, because you have to go back and check every one of those wells. It is going to be a tremendous job. That checking may develop some matters we want to cross examine upon. I don't know that it will. The exhibits have been marked and they are in the record. If we can have until the next session to check it over, we believe it would facilitate things. We could do that, making some sort of a check on it, and then we could cross examine upon it then. It wouldn't embarrass or delay you any. In other words, in that manner you can accomplish the same thing.

Mr. March: We object to the withholding of the cross examination of this geologist until we get to Washington. This is the same type of exhibit as 259 was. I cross examined upon that without any delay. There were a bunch of wells, two or three hundred listed thereon. They obtained these exhibits Saturday and there is no reason we can't have the cross-examination upon them now. If we wait until we get to Washington, it may be reopened again. My arrangement with Mr. Spencer was, as I stated, clearly understood. There is a simple cross examination that should be had upon

it now. If there are any errors in here, a motion will be in order to strike if it is admitted in evidence. Commission's counsel absolutely takes exception to any dilatory delay in the cross examination. There is no reason for it.

Mr. Keffer: There is nothing dilatory about it, Mr. March, as I am trying to expedite the matter.

Mr. March: It is coming to the matter of a stall when another arrangement was made.

Mr. Keffer: Mr. March, there is no basis for that statement.

Mr. March; This is basic data. Mr. Peterson prepared an exhibit of gas produced by the field. I subsequently found that I forgot to ask him for the working papers that he used. I cross examined Mr. Peterson and I didn't hesitate about doing it, either. Our witness is not making any construction of the data. The interpretation there *speak* for itself.

The Trial Examiner: Well, I think perhaps, Mr. Keffer, if you have any questions of Mr. Hammer as to the foundation for the exhibit, you might proceed in that manner at this time. Then, as I understand it, if upon checking the data it is shown that an error has occurred, the error may be either corrected or stricken from the record. Is that the situation, Mr. March?

Mr. March: Or the correct figures may be given by Mr. Keffer.

Mr. Keffer: That is perfectly all right, Mr. Examiner, but my only thought was this: I didn't hear the agreement between Mr. Spencer and Mr. March, but as I understood it, as Mr. Spencer detailed it to me, there was to be no cross examination at this time.

Mr. March: Mr. Spencer has specifically stated that the Examiner would rule upon the thing and it was predicated upon a motion to strike. As a matter of fact, the only cross examination that would be appropriate would be where he got the information and data.

Mr. Keffer: I don't know that it will be, Mr. March.

Mr. March: That is an old thing, to delay this proceeding. The time has come that Mr. Keffer might cross examine here for a change. He has had since Saturday to look over this and if there are any errors, as I discussed it with Mr. Spencer, if any errors develop, they may be brought to the attention of the Examiner in Washington and a motion lodged to strike if the Examiner admits the exhibits in evidence. It is perfectly in order, and for Mr. Keffer to try to keep this geology open and hold up the cross examination of one of our witnesses, Mr. Hammer, we most vigorously except and we urge that Mr. Keffer proceed with the cross examination. That was not my agreement with Mr. Spencer.

Mr. Keffer: My only point is this: I can't tell whether there would be any cross examination upon this or not but I think it is obvious to anyone looking at those two exhibits, to have checked them since Saturday—that is preposterous. I think Mr. Hammer will agree with me on that. My only thought is, I certainly wouldn't want to waive the right to cross examine. Everything else is perfectly satisfactory to me. There may not be any cross examination on this exhibit or these exhibits, but I can't tell as I haven't the slightest thought on the matter at this time.

The Trial Examiner: Well, Mr. Keffer, supposing if you have any questions as to the foundation, you ask those now and the Examiner will then act upon the offer of Commission's counsel, and the reservation that has been made may serve to eliminate any possibility of inclusion of errors in these particular exhibits. It seems to me on that basis there is really not much harm that could come from the exhibits themselves.

Mr. Keffer: I appreciate that. As I stated a moment ago, my only thought was, as we do get into checking these items it may develop from the Examiner's standpoint, as well as our own, to have some cross examination upon those things. The chances are there will be none. In fact, I can't see right now that there will be, but there might be, and it is a matter that I haven't explored yet.

Mr. March: As the Examiner can see, it is just like the other exhibits put in by counsel for the companies. It is just statistical data. In fact, some of the basis statistic data

was used in the estimate of reserves subsequent to 1935. There is no construction being made of this. The only type of cross examination there could be on exhibits of this nature would be as to the source of information and where he got the data. If there were errors made, there could be motions made to strike. To leave that open until we get to Washington and reserve Mr. Keffer the right to cross examine there, this thing might go on for weeks.

"What do you know about that well, Mr. Hammer? What is your construction of that well there, Mr. Hammer?"

Mr. Hammer hasn't made any construction of the exhibits. The figures speak for themselves, and there is no reason in the world why Mr. Keffer, as able a lawyer as he is, knowing about these wells and living in that vicinity, can't proceed with the cross examination here when I cross examined upon the other exhibits right off the bat.

Mr. Keffer: I'm not as smart as you are, Mr. March, and I can't do it that way.

I am going to cross examine, Mr. Examiner, reserving the right by reason of the matters stated here in open court, for future cross examination if an inspection and test of the exhibits would lead me to believe that further cross examination would be necessary or desirable.

Mr. March: We object to that. He can cross examine now and make his motion to strike in Washington if there appears to be errors in the exhibits.

Mr. Keffer: I don't see how we can make a motion to strike under the circumstances. Mr. Hammer has one set of figures here and should we say there should be something else and we should strike Mr. Hammer's figures?

Mr. March: You had six months to bring in the data on the wells. Why didn't you bring that data in here?

The Trial Examiner: I think we are spending considerable time on a matter that can be worked out to the satisfaction of all concerned. I don't think, Mr. Keffer, the Examiner is going to take any step that might jeopardize your rights in the proceeding. On that assumption, as I have stated, I think if you have any questions as to the founda-

tion, you may ask them and we will act upon the exhibit now and we will cross the next bridge when we come to it.

Mr. Keffer: All right.

Cross Examination

By Mr. Keffer:

Q. Now, Mr. Hammer, I note that you show production prior to August 1, 1935. When you were speaking about it a while ago, you were speaking a little low and I didn't quite hear you. You might have stated how you got that, but I didn't catch it.

A. All of the data on all of these sheets are data that were taken from the records of the Texas Railroad Commission.

Q. Well, take wells over in the Sanford area, for example, and perhaps some other wells which you have included on this statement where production records were not complete prior to August 1, 1935. How did you handle that?

A. The only thing is, these represent the records of the Texas Railroad Commission. If there were wells where the records weren't complete, naturally this doesn't show it.

Q. Did you find any that were not complete?

A. That would be a hard thing to answer on all of the wells there.

Q. But you spent quite a little time gathering this data and I wonder what you found in that respect.

A. I couldn't go back and give you definite information on wells and I don't intend to do that.

Q. I haven't asked you to do it. I am just asking what you found in that respect.

A. Unquestionably there are some wells upon which the data are not complete and I know that. I lay no particular stress at all on this data prior to 1935.

Q. The upshot of it is that you will acknowledge on your production records, at least, that your data is incomplete?

The Trial Examiner: Prior to 1935?

Mr. Keffer: August 1, 1935.

The Witness: Yes, there is that possibility.

By Mr. Keffer:

Q. Not only a possibility but a probability?
A. That is right.

Hammer again testified with respect to the production data as follows:

"Q. You did have complete production figures?

"A. I didn't have, no, and I have so stated to you.

"Q. Did you mean to say here that your production figures back of 1935 have no relevancy?

"A. Nothing particularly—no particular relevancy as far as these exhibits are concerned." (P. 15588).

Mr. Hammer again testified:

"Q. Mr. Hammer, I take it you yourself wouldn't want to rely upon those figures?

"A. Prior to 1935?

"Q. Prior to 1935.

"A. Well, I didn't." (P. 15589).

Mr. Hammer again testified on redirect examination (Vol. 101, pp. 15590-15591) as follows:

By Mr. March:

Q. Mr. Hammer, you did make an effort, did you not, to get reliable data prior to 1935?

A. I made every effort possible.

Q. You were unsuccessful?

A. That is right.

Q. You believe that the data which you got prior to 1935 is the best data that can possibly be gotten in regard to metered gas?

A. Yes, I do.

Q. Mr. Hammer, there have been some questions here raised as to the fact that you leave off certain pressures. As a matter of fact, the only thing you vouch for here is the figures you have recorded here?

A. That is right.

Q. In other words, if it should happen there are some pressures which are recorded by the Railroad Commission which you do not have, it would be merely an oversight on your part and you are merely testifying to the figures which you have here in the exhibit?

A. That is right. Where certain data isn't contained here, it is simply a case of where the records of the Texas Railroad Commission showed no data for those periods.

Mr. March: That is all.

Mr. Keffer: That is all.

The Trial Examiner: You may step down, Mr. Hammer.

(Witness excused.)

Mr. March: I move for the admission of the exhibits, Mr. Examiner—I think the relevancy is obvious of Exhibits 294 and 295—with the understanding that the motion to strike will be in order when we reconvene in Washington, as agreed by Commission's counsel and Mr. Spencer.

Mr. Keffer: I have no objection, Your Honor, to the admission of the exhibits as such, except as to the stock objection as to the relevancy and materiality, but with the reservation to cross examine further concerning them if upon further check it is deemed desirable.

Cotner and Crum Report

Commission Counsel introduced into evidence an article entitled, "Geology and Occurrence of Natural Gas in Amarillo District, Texas," by Victor Cotner and H. E. Crum in collaboration with other geologists, and which article was published in August, 1933, in Volume 17, Number 8, of the Bulletin of the American Association of Petroleum Geologists. This article has been designated as Exhibit 215. Said publication, in so far as pertinent in this proceeding, is as follows:

Volume 17 Number 8

Bulletin of the American Association
of Petroleum Geologists
August 1933

Geology and Occurrence of Natural Gas in Amarillo District, Texas*

Victor Cotner** and H. E. Crum***
Amarillo, Texas, and Charleston, West Virginia

Abstract

Natural gas is found throughout an almost continuous belt extending from central Beckham County, Oklahoma, northwestward to northern Moore County, Texas, and thence northward to and including Morton and Stevens counties, Kansas. This belt of productive gas territory is more than 200 miles in length and ranges from 5 miles to 40 miles in width and embraces an area of proved and semi-proved gas territory of more than 2 million acres, one of the largest and most important gas areas in the world. Gas is produced from beds of Permian and Pennsylvania age. Accumulation of gas is closely associated with deposition and folding of these beds in relation to a buried mountain range known as the Amarillo Mountains. Natural gas has been known to exist in this area since 1918. From that time it has developed in economic importance until today it occupies first place in production of natural gasoline and carbon black and is rapidly becoming the largest producer of natural gas for domestic and industrial use. Natural gas is now being transported from this district by pipe lines to such distant points as Chicago, Indianapolis, Denver, and Fort Worth. The writers discuss the geologic occurrence of the gas and set forth production data in connection with its utilization.

*Presented before the Association at the Oklahoma City meeting March 24, 1932. Manuscript received, March 10, 1932. Reprinted from Geology of Natural Gas, a special symposium on world occurrence and geology of natural gas which will include authoritative papers on the gas fields of North America, Europe, and Asia. Geology of Natural Gas, now in manuscript form, will contain more than a thousand pages.

**Columbian Carbon Company.

***Idem.

Acknowledgment

The following geologists have contributed material or criticism in the preparation of this paper, to all of whom the writers express their appreciation: L. M. Oles of the Prairie Oil and Gas Company; J. D. Thompson, Jr., consulting geologist; W. E. Hubbard of the Humble Oil and Refining Company; T. F. Newman of the Skelly Oil Company; Frank T. Clark of the Empire Gas and Fuel Company; and Richard W. Camp of the Consolidated Gas Utilities Company.

Introduction

The Amarillo district embraces the Hugoton district of southwestern Kansas, the Oklahoma Panhandle, the Texas Panhandle, and the Sayre district of southwestern Oklahoma. This area, with the exception of the Sayre district, lies in the High Plains Province. The Sayre district lies just below the rim rock which borders the High Plains Province on the east. The High Plains Province is an almost treeless plain covered with alluvial deposits except along the larger streams where erosion has cut deep canyons in which the underlying Triassic and Permian strata are exposed.

Production of gas in this district is closely associated with a system of buried mountains or granite ridges extending northwestward from the Wichita Mountains of Oklahoma. The sedimentary formations which overlie these buried mountains have been folded into an arch over the granite core and form an immense anticlinal fold into which the gas and oil have migrated and accumulated. From the crest of the anticlinal fold the beds dip away northeastward into the Anadarko basin, southwestward into the West Texas Permian basin, and westward in the Dalhart basin. Separate domes and basins occur within the area, but these features are probably related to the principal mountain system. On the northwest insufficient drilling has been done to define clearly the limits of the district. Figures 1 and 2 set forth these relationships.

Economic History

Gas in this district was discovered in northern Potter County, Texas, in December, 1918. This discovery was on a surface anticlinal fold surveyed by Charles N. Gould, geologist, and called the John Ray dome. Drilling of the

discovery well was recommended by Gould, and gas was encountered at a depth of 2,605 feet. The first commercial well in the Sayre district, Beckham County, Oklahoma, was completed in July, 1922, gas being encountered at a depth of 2,755 feet. Gas was discovered in Seward County, Kansas, in December, 1922, but not until May, 1927, when the first gas well of Stevens County was brought in by the Independent Oil and Gas Company at a depth of 2,617 feet, did this district become important. In 1925 and 1926 several gas wells were completed in Texas County, Oklahoma. All of the discovery wells were similar in that they started at or close to the same geologic horizon, penetrated similar strata, and encountered the first showings of gas in the dolomite series of Permian age. This similarity was readily noted at the time but that these wells had roughly defined the extent of the immense gas field which we know today was not recognized until long afterward. They were considered to have opened separate and local fields.

The discoveries of gas in this district were made during the search for oil, and the finding of gas was not hailed with enthusiasm. The search for oil continued with the result that the proved gas areas have expanded to their present known limits. Only since trunk lines have been laid to distant markets has an effort been made to develop the gas reserves. Immense volumes of gas were encountered in wells which succeeded in producing oil. In the early development of the oil fields, little effort was made to conserve this gas and the wastage was enormous. Later the operators adopted conservation methods of drilling through the gas strata with less wastage of gas.

There are now eight counties in the Texas Panhandle from which gas is being marketed, while in four others gas has been found in commercial quantities. Gas has been found in two counties in the Oklahoma Panhandle, one of which is marketing its product. The Sayre district, in Beckham County, Oklahoma, has been marketing gas in limited quantities since 1923. The Hugoton district, in southwestern Kansas, has many shut-in gas wells which are being connected to trunk lines. Lines are now carrying gas from the Amarillo district to such distant markets as Chicago, Des Moines, Indianapolis, Denver, Midland, Wichita

Falls, Enid, and Kansas City. This marketing development has taken place principally during the past four years. Lines under construction will soon extend the markets to include St. Paul and Minneapolis.

Geology Pertaining to Occurrence of Natural Gas
Regional Stratigraphy

Table I shows a correlation of geologic formations which are found in the Amarillo district and the neighboring districts. Gas occurs in the lowest formations of the Permian and the highest formations of the Pennsylvanian, these beds having been deposited in and along the southwest flank of the Anadarko basin and the north flank of the West Texas Permian basin. The Granite wash and the "Gray lime," both of Pennsylvanian age, show definite evidence of shoreline deposition. Along the flanks of the buried mountain range, there is a progressive overlap of formations against the granite core (Fig. 2). The "Gray lime" is confined, except in the low gaps, to the flanks of the ridge, while the dolomite and anhydrite series, both of Permian age, were deposited over the mountain ridges. There are two known possible exceptions where the granite peaks are found in contact with the "Red Cave" and even in these localities there is evidence that the dolomite and anhydrite have been removed subsequent to deposition. There is an unconformity at the top of the anhydrite and possibly an unconformity at the top of the "Gray lime."

Producing Horizons

The producing horizons of this district are the dolomite series of Permian age, the "Gray lime" of Pennsylvanian age, and the granite wash of Pennsylvanian age. Figure 2 shows cross sections of the gas-producing counties. These sections are built up from wells logs and sample data and show the structural attitude of the producing horizons, erosional and depositional features and their relation to the granite ridge.

The most widespread gas-producing horizon is the dolomite series, which is productive in the higher portions of the

Table 1
Correlation Table

	Eastern New Mexico	Texas Panhandle	Western Oklahoma	Southwestern Kansas
Tertiary	Caliche			
				Cretaceous
Triassic	Chinle Shinarump Moenkopi	Trujillo sandstone Tecovas shale		
Permian	Red Beds	Quartermaster	Quartermaster	Big Basin
	Rustler dolomite Salt series	Alibates Cloud chief	Cloud Chief Day Creek	Cloud Chief
	Anhydrite and sand	Whitehorse	Whitehorse	Whitehorse
	San Andres	Blaine	Dog Creek Blaine	Dog Creek Blaine
	Glorietta	San Angelo-Duncan	Chickasha-Duncan	Flowerpot Cedar Hills Salt Plains Harper
	Yeso	Salt series Red Cave	Hennessey-Garber	Hennessey Wellington
	Abo	"Big Lime" ((Anhydrite (Dolomite ((	Wellington Stillwater	Wellington Marion Chase Council Grove
Pennsylvanian	Magdalena	("Gray lime" ((Granite wash	Wabaunsee	Wabaunsee
Mississippian (?)		Chert and siliceous limestone		Boone(?)
Ordovician(?)		Frosted sands dolomite, and limestones		Simpson(?)

Amarillo arch and northward across the Oklahoma Panhandle and into the Hugoton district of Kansas. This horizon consists of buff to white crystalline dolomite interbedded with gray shale. The dolomite has an colitic phase throughout the Texas Panhandle, though in the Hugoton district sands appear locally at this horizon in this series.

The "Gray lime" is less widespread, being absent in the upper parts of the Amarillo arch, in the eastern counties of the Texas Panhandle, and in the Sayre district. In the western and northern counties of the Texas Panhandle this horizon is the source of the largest gas wells. Close against the Granite ridge it contains lentils of granite wash and in other localities it shows evidence of local fracturing, faulting, and solution cavities which when encountered yield the larger wells.

The Granite wash lies immediately over the granite mass except toward the basins, where it has been found to overlie beds of probable Mississippian or Ordovician age. Granite wash is the resulting material derived from disintegration of the granite mass following mountain-building movement. The granite gravels have been washed out from the main granite mass and have accumulated in the valleys and depressions and as alluvial deposits along the lower flanks of the mountain range. Local deposits of granite wash are found high on the granite slopes. Granite wash production is confined to the Texas Panhandle.

Gas wells have been found locally in fractures and the weathered surfaces of the granite core, the most notable being in Gray County, Texas.

Structural History

It is agreed by those who have studied the Wichita Mountains of Oklahoma and the Texas Panhandle that uplifting of this mountain system has occurred at several periods since the first movement in early Pennsylvanian time.

The uplift in the early Pennsylvanian was followed by partial erosion of pre-Pennsylvanian sediments from the uplifted portion. A barrier was formed separating the Anadarko and West Texas basins. Deposition in these basins continued until, in the later Pennsylvanian, another uplift

occurred along the mountain chain. Erosion following this movement completely denuded the granite ridge of Pennsylvanian and older sediments and the granite core itself was attacked by the forces of weathering and erosion. Oscillating shore-line conditions were brought into existence along the mountain front, and sands and arkoses from the granite ridge were being carried outward and intermingled with the shales and limestones being deposited in the basins. Arkosic limestones, shales, and dolomites are characteristic of the late Pennsylvanian sediments (Cisco-Wabaunee) close to the Amarillo Mountains.

Interfingering of arkosic material with basin sediments continued during the subsequent deposition of Permian dolomite and anhydrite until the granite peaks were entirely covered. By this time all but the very highest peaks on the ridge had been covered by dolomite.

Following the deposition of anhydrite which marked the close of the "Big lime" time another upward movement of less magnitude occurred which was accompanied by faulting and folding of the sediments. Subsequent erosion removed the anhydrite and dolomite from the highest peaks and removed part of the anhydrite from less lofty parts of the buried mountain chain. This erosion is testified by finding pieces of anhydrite and dolomite embedded in the lower part of the "Red Cave" section near and on the highest peaks. The cross sections of Figure 2 show that faulting occurred following "Big lime" time. Increase of the throw of those faults with depth indicates that this faulting occurred in the granite basement rocks during earlier movements and that the later faulting had occurred along the old lines of weakness.

The arching of Permian and Triassic beds into the anticlinal fold which is superimposed above the Amarillo Mountains has been brought about largely through subsidence of the basins and compaction of the basin sediments. Lesser movements along old lines of weakness are also indicated as having taken place during and following the deposition of these younger beds.

Structure

The structure of the sedimentary rocks which contain gas and oil in the Amarillo district consists of a broad arching of these beds over the buried Amarillo Mountains. Local structure is influenced by irregularities of the mountain range such as peaks, gaps, valleys, and fault scarps. The overlying sedimentary beds have been warped to conform with these irregularities upon which they have been deposited. The arching of the beds has been accentuated by successive uplifting of the mountains and by settling of the basins. Some minor folding along the flanks of the main uplift may be due to lateral pressures induced by the uplift of the ridge or by faulting at these periods. Figure 1 shows the regional structure of the district based on elevations on the top of the anhydrite series ("Panhandle Big lime"). Figure 2 shows cross sections of the various gas-producing counties.

It is a coincidence in the Amarillo district that the water level in each porous horizon occurs at or close to sea-level. Above the water level a band or zone of oil occurs and the upper portions of the anticlinal fold contain gas only. With this simple structural arrangement of the water, gas, and oil it is necessary only that the porous horizon lie above sea-level at the site of the test well in order to secure gas or oil production. The amount of production obtained in the proved area depends solely on the local porosity. Perhaps nowhere in the world is there an area of comparable magnitude in which oil or gas operators may proceed with their development with such assurance of obtaining the desired result. In the oil- and gas-producing counties of the Texas Panhandle, the ratio of dry holes to producing wells is 1:15; for the entire district, the ratio is 1:11. In the defined gas areas, the number of dry holes is practically negligible.

Along the general course of the main Amarillo anticline there are several local domes. The discovery well of the district was drilled on the John Ray dome in Potter County. The first oil well of the district was drilled on the flank of the 6666 dome in Carson County. The LeFors dome in Gray County is noted for its large gas wells, as is likewise the Lela dome in Wheeler County. Other domes which are

closely associated with the main uplift are the Bush dome, in Potter County, which is noted for its helium gas production, and the Sayre dome in Beckham County. The last named domes are separated from the main uplift by faults as shown by the cross sections. The Bravo dome, in Oldham County, has been tested by drilling and found to be nonproductive of oil or gas. The "Big lime" is entirely missing, the "Red Cave" resting on the Granite wash. It is an accepted belief that the Bravo dome was a land mass during "Big lime" time. Minor folds and flexures occur along the flanks of the main uplift, notably in southwestern Hutchinson County and eastern Moore County.

In the northern Texas Panhandle, the Oklahoma Panhandle, and the Hugoton district of Kansas no anticlinal folding is known to exist which is comparable in area or in structural relief with those here described. In these areas the structure appears to be monoclinal, with the gas accumulating up-dip in porous dolomite or sandstones which lens out up the dip westward. However, further development of these areas and the drilling of magnetic "highs" may yet demonstrate some anticlinal folding.

In determining the location of buried granite ridges in this district the magnetometer has proved very accurate and, because of the close association of gas and oil occurrence with these granite ridges, this instrument has demonstrated its commercial value. Magnetometer surveys in the Amarillo district have not only delineated granite ridges, but they have also indicated the location of faults. The northern portion of the district has been mapped in great detail by the magnetometer, but insufficient drilling has been done to demonstrate whether the "highs" which have been found reflect the presence of similar granite ridges. South of the Amarillo Mountains several test wells have been drilled on magnetic "highs," but the drill failed to show other than normal conditions. Whether other influences than the granite basement were affecting the instrument or whether the interpretation of the readings in these early surveys was at fault is not known.

Reservoir Rocks

The reservoir rocks of the gas and oil fields of this dis-

trict consist of dolomite, limestone, sandstone, and arkose (granite wash). The dolomite is white to buff crystalline or oolitic. It occurs as a blanket formation over almost the entire district, retaining an average thickness of 250 feet. In a driller's log the first recorded showing of gas generally marks the top of this formation. Because of the variability in thickness of the overlying anhydrite series, geologists are noting carefully this datum point for constructing contour maps. The largest production comes from the oolitic zones. As shown by the cross section in Figure 2, the dolomite thickens basinward. The limestone is referred to locally as the "Gray lime." It lies next below the dolomite series in the geologic section. It does not produce oil or gas east of central Gray County, Texas. Production from the "Gray lime" is due to the presence of dolomitic and arkosic phases and to the occurrence of fractures. In Moore County this formation accounts for the oil production and for most of the gas production. This formation likewise thickens rapidly basinward.

The arkose in this district is known as Granite wash It varies in character from fine granite sand to large granite boulders. Where most productive of gas and oil, it consists of coarse arkosic sand and gravel. Its porosity is highly variable along the flanks of the anticline, due to its being impregnated locally with red shales or lime cementing materials. Where no red shales or cementing materials are present, this formation is the most highly productive in the entire district. The gas of the eastern Texas Panhandle comes almost entirely from the Granite wash, because throughout most of this area the dolomite and "Gray lime" are missing at the gas-producing datum levels. The Granite wash is also important as a gas producer in northern Potter County. It is known to exceed a thickness of 700 feet locally.

Closely related to the arkose horizon, and difficult to distinguish from it, is the zone of weathered and fractured granite in place. A study of the granite surface at the outcrop in the Wichita Mountains of Oklahoma shows that

weathering has produced a large number of fractures and joints in the granite and also that leaching out of the ferro-magnesian minerals has left cavities in the granite which are an ideal reservoir for gas and oil accumulation. Large wells have been encountered in this zone, notably in Gray and Wheeler counties.

A striking feature of the producing horizons is their remarkable continuity. The dolomite is practically continuous and its porosity is notably uniform throughout the area. The "Gray lime", although not present except locally over the ridges, produces gas or oil in a continuous band 60 miles in length. The Granite wash, although present only locally on the ridges, produces gas or oil in a continuous band for a distance of more than 70 miles.

Reservoir Cap Rocks

The reservoir cap rocks of the Amarillo district may be classified as primary. Gas or oil is found in the dolomite when the drill has penetrated through the impervious anhydrite series. In the "Gray lime" producing horizon, the gas is found usually beneath a bed of shale or dense limestone which constitutes the cap rock. As a general rule, the upper part of the Granite wash contains beds of red shale and it is only after the drill has passed through these red shales that oil or gas is encountered. It would seem, therefore, that the cap rock beneath which oil or gas is found in this district is in its original state and has not been altered to its present impervious condition.

Oil

In this district oil occurs within the same reservoirs as the gas and water, there being no classification of "oil sands," "gas sands," and "water sands."

To date no oil has been encountered in the Hugoton district, and the Oklahoma Panhandle has had but one showing of oil, while the Sayre district had two or three commercial wells during its early life. The Panhandle of Texas

has been a major oil-producing district since the fall of 1925. The oil is produced from twenty-seven localities or so-called "pools" distributed throughout a narrow band 90 miles in length and lying along the north flank of the Amarillo arch. One minor discovery of oil has been made on the south side of the arch in Carson County in close proximity to a probable fault. No oil has been found to date on the Bush dome in Potter County, but this is not conclusive evidence that oil will not yet be found on this fold. The encountering of a small quantity of oil in the dolomite close to the Potter County fault indicates that oil may yet be expected whenever further development is carried on.

Migration of Oil and Gas

From the fact that the Anadarko basin contains carbonaceous formations in the Pennsylvanian and in the older Paleozoic rocks, though neither the presence nor absence of such beds has been demonstrated in the West Texas Permian basin adjoining the Amarillo Mountains, it is assumed that the gas and oil have migrated into the anticlinal folds from the Anadarko basin. The further fact that all of the important oil fields of the Texas Panhandle lie on the flank of the arch toward the Anadarko basin supports this view. The reservoir rocks are of late Pennsylvanian and early Permian age and the principal uplifting and folding of these beds has occurred at various times since early Pennsylvanian. Considering the origin of the reservoir rocks, it seems plausible to assume that the accumulating gas has displaced water within the reservoirs.

* * * * *

Volume

Many wells capable of producing large quantities of gas have been drilled through the gas to the oil "pay." In the following tabulation, only wells completed as gas wells are listed. Wells have not been segregated as to the different zones from which they may be producing. Initial open flows of gas wells vary from two million cubic feet in a few small wells to wells in excess of 100 million. The production is dependent upon local porosity. Wells near to each other may vary considerably in open flow volume, but their rock pressures are the same. Certain areas develop large open

flows, but almost in the center of such areas very small wells may be encountered, which is due either to a granite peak cutting out the porous zones or red shale cementing the Granite wash or the dolomite zone being less porous. The 703 gas wells of the Panhandle district show an average open flow of 26.8 million cubic feet per day.

Table II

Annual Completions, Texas Panhandle

Year	Number of Gas Wells
1926 and earlier	62
1927	92
1928	140
1929	144
1930	169
1931	69
1932	27
Total to date	703

Table III

Gas Wells in Panhandle Field as of December 31, 1932

County	Number of Wells	Initial Open Flow Thousand Cu. Ft. Per Day	Average Open Flow Per Well in Thousand Cu. Ft.
Carson	165	4,950,000	30,000
Gray	118	2,209,300	18,723
Hartley	7	119,500	17,100
Hutchinson	99	2,911,600	29,410
Moore	57	1,322,700	23,205
Potter	36	879,100	24,419
Wheeler	221	6,443,800	29,200
Total	703	18,836,000	26,793 average for field

Table IV
Estimated Gas Withdrawals from Texas Panhandle

Year	Thousand Cu. Ft. by Public Utilities Companies	Thousand Cu. Ft. Casinghead Gas Treated for Gasoline	Thousand Cu, Ft. Casinghead Gas Not Treated (Blown in Air)	Thousand Cu. Ft. Blown in Air During Drilling in Gas Wells	Thousand Cu. Ft. Blown in Air During Drilling in Oil Wells
1926 & earlier	15,725,533	34,300,000	92,000,000	17,200,000	88,200,000
1927	8,825.598	263,800,000	144,000,000	24,400,000	64,200,000
1928	39,987,176	330,500,000	114,000,000	30,000,000	19,500,000
1929	84,767,509	395,110,000	90,000,000	25,800,000	30,000,000
1930	81,175,878	412,796,000	70,000,000	27,800,000	24,800,000
1931	86,538,708	346,255,000	50,000,000	9,800,000	6,500,000
1932	x97,168,645	x281,524,155	32,940,000		
Total	414,180.047	2,064,285,155	592,940,000	135,000,000	233,200,000

Total estimated withdraws from field 3,439,405,202 thousand cubic feet.

During 1931 there were 69 gas wells completed for an average open flow of 26,262,000 cubic feet per well.

During 1932 there were 27 gas wells completed for an average open flow of 23,215,000 cubic feet per well.

Annual withdrawal figures are not available in accurate amounts. Many statements have been made as to gas flowing to waste in the Panhandle field, but, due to the large area included in the drilling operations, the figures have probably been only a rough estimate.

Table IV shows an estimate of the total gas withdrawn from the Panhandle field from its first development until January 1, 1933. The estimate presents an idea of the probable total amount of gas withdrawn from the field. Several of the items in the estimate are comparatively correct, but others are speculative and may vary considerably from the true amounts. Withdrawals by public utilities companies from 1932 show an increase over 1931 due to the completion of several major gas pipe lines during 1931. During the same period there has been a reduction in casinghead gas volume.

The producing area of the Texas Panhandle field is estimated at approximately 1,300,000 acres (Fig. 3). Of this amount, 100,000 acres has been drilled for oil production, although this has not been fully drilled up and may not all be productive of oil in paying quantities. Of the total gas area, that part on which initial volume of 10 million open flow per well or larger may be expected consists of approximately 896,500 acres. Initial volume contours of the field would show that a belt of small volumes extends around the outer edge of the producing area. Some small areas of less than 10 million volume exist within the larger open flow areas, being due to porosity factors previously mentioned.

Pressures

The rock pressure of Panhandle field is sub-normal, being less than half the normal hydrostatic head, and is uniform throughout the area, excepting the Bush dome in Potter County. The fact that pressure is equal and uniform in all productive zones indicates communication of the porous strata at the unconformity along the surface of the buried granite ridge.

The controlling pressure factor is not definitely known. The porous strata of the producing zones do not crop out at any known place in the form in which they are found in the wells. The character of the producing strata changes to shales and non-porous materials where their equivalents crop out. It is therefore assumed that at this time the producing zones are not exposed to a definite known hydrostatic head as a source of supply and that the pressure now existing was created when the producing zones were exposed to sea waters of former times. However, some geologists attribute the pressure to the hydrostatic head originating where the sedimentary rocks are in contact with the granite in the Wichita Mountains in Oklahoma at approximately 1,000 feet above sea-level.

The initial rock pressure of the Panhandle field was 430 pounds per square inch. Variations of 10 pounds have been noted on well completion records which may have been due to inaccurate gauges.

Decline in pressure is greatest throughout the areas developed for oil. This has been caused by the withdrawals of immense quantities of casinghead gas as well as gas wasted when drilling through gas strata to the oil "pay." From the developed oil fields the pressure increases rapidly into the main gas-producing areas.

The following data give some idea of the present rock pressures in the gas-producing areas. The pressures were taken in June, 1931, at gas wells only.

Most of the rock pressures in the producing oil areas are considerably lower than those given in Table V.

The Bush dome in Potter County had an original rock pressure of 723 pounds. The pressure in December, 1931, was approximately 710 pounds.

Table V

County	Maximum Pressure in Pounds	Minimum Pressure in Pounds	Number of Wells Gauged	Average Pressure in Pounds
Carson	430	300	88	353
Gray	425	245	32	355
Hartley	426	425	4	425
Hutchinson	410	155	28	363
Moore	430	374	33	420
Potter	428	400	33	418
Wheeler	430	314	86	386

Recoveries

The great variation of open flow of wells in the Texas Panhandle indicates considerable differences both in porosity and thickness of the pay strata. Porosity is the main factor. This is probably substantiated from well-log records on pay thickness. Also with the different pay horizons it can readily be seen that estimates of reserves in the field should be calculated by the pressure-decline method. With this method it will prove difficult to obtain accurate results due to the fact that the area of the field is so large that simultaneous records of the wells are difficult to obtain as to withdrawals and pressures. Many estimates have been made on recovery

per acre by engineers for the pipe-line companies, the more recent estimates ranging from 12 million to 17 million cubic feet per acre. In 1927 C. Max Bauer, assuming that the ultimate recovery would be 50 per cent, estimated the total recoverable gas in the reservoir at 4,436 billion cubic feet, but there are more data available at this time. Accordingly the Bauer estimate of total gas per acre was 9.2 million cubic feet.

As no water is present, on structure, in the gas pays or directly under them, the Panhandle field will no doubt have an ultimate recovery of all gas in the reservoir with the exception of a very small percentage.

It is now estimated that there are 896,500 acres in the Amarillo district in which wells will be completed with an average initial open flow of 10 million cubic feet or more; that the average thickness of "pay" is 65 feet; the average porosity is 20 per cent; and the initial reservoir pressure was 430 pounds per square inch. Reduced to a 2-pound base, the preceding data give an estimate of 15,289,000 cubic feet per acre, and an original reservoir content of 13,706,588.5 million cubic feet of gas.

In addition to the foregoing area, there are gas-bearing areas of smaller open-flow volumes and oil-field areas in the Amarillo district which must be considered. These areas are estimated to cover 403,500 acres. They include localities where wells are expected to produce less than 1 million cubic feet on completion. It is estimated that 6 million cubic feet of gas per acre will be recovered from these areas, giving an additional reservoir content of 2.4 trillion cubic feet, and a total original reservoir content of 16.1 trillion cubic feet or gas in the Amarillo fields.

The foregoing figures are simply an estimate and must be considered as such, but are given in order to show the tremendous amount of gas within this great reservoir.

If it is assumed that estimates of gas withdrawals in Table IV are approximately correct, there is now an approximate reserve of 12.7 trillion cubic feet of gas in the Panhandle field at this time, or about 79 per cent of the original amount.

Ultimate recovery per well will no doubt show marked variations. The following data are from a gas well in Gray County and are given as an example of recovery per well in an area where there are no near-by offsets. The records show that 4,327 million cubic feet of gas were withdrawn in a period of three years; rock pressure declined 20 per cent; and the open-flow volume declined 42 per cent. A gas well in Potter County has produced 14,840 million cubic feet of gas to date, while the pressure declined from 430 pounds to 395 pounds. A gas well in Wheeler County has produced 7,970 million cubic feet of gas to date. These wells are special cases and do not represent an average.

During 1931 the Panhandle field produced 21,137,355 barrels of oil. During 1932 it produced 18,014,920 barrels of oil making a total to December 31, 1932, of approximately 194 million barrels of oil produced from this field.

Utilization of Gas

Table VI shows that approximately 4,200 miles of major gas pipe lines have been built to take gas from the Panhandle. This does not include any lateral or branch lines. The major gas lines have an estimated daily capacity of 887 million cubic feet per day and the local lines a capacity of 80 million cubic feet per day, or a total pipe-line capacity of 967 million cubic feet per day.

There are several other smaller pipe-line companies serving local towns in the Panhandle district.

Gasoline Plants

Most of the casinghead gasoline plants are of the absorption type and are operated on direct well pressures and by compressors. On January 1, 1931, there were 50 casinghead gasoline plants in the Texas Panhandle, estimated to have a daily capacity of 1,024,500 gallons and capable of treating 1,407 million cubic feet of gas daily.* There are also 5 gas-

*Editor's Note.—According to testimony at a hearing before the Texas Railway Commission at Pampa, Texas, February 15, 1932, about 1 billion cubic feet of gas is passed through natural gasoline plants daily. About 530 million cubic feet of the residue gas is used daily for the manufacture of carbon black and sold to gas transmission lines, and approximately 470 million cubic feet of residue gas is wasted to the air or burned by flares.

Table VI
Pipe Lines Obtaining Gas From Panhandle Field

Company	Size in Inches	Length in Miles	Daily Capacity Thousand Cu. Ft.	Withdrawal for 1932 in Thousand Cu. Ft.	Terminal
Amarillo Oil Co.	12	45	30,000	1,545,278	Amarillo, Te
Canadian River Gas Co.	22-20	340	125,000	12,170,499	Denver, Col
Central States Power & Light				504,172	Pampa, Tex
Cities Service Gas Pipe Line	20	400	125,000	27,677,064	Kansas City Mo.
Consolidated Gas Utilities	14	180	35,000	6,902,258	Enid, Okla.
Lone Star Gas Co.	18	200	50,000	7,318,658	Petrolia, T
Natural Gas Pipe Line of America	24	925	175,000	26,198,952	Chicago, Ill.
Northern Gas & Pipe Line Co.	24-20	850	150,000	1,836,679	Rochester, Minn.
Panhandle-Eastern Pipe Line	24-20	1,100	150,000	2,449,215	Indianapoli Ind.
Panhandle Power & Light Co.	8		10,000	279,181	Local—Tow in Panhan district
Public Service Corp.	6		7,000	357,806	Local—Tow in Panhan district
South Plains Pipe Line Co.	16	260	35,000	3,479,360	Midland, T
Shamrock Gas Co.	6		8,000	138,529	Shamrock, Tex.
United Gas Co.	16-14	170	42,000	4,655,581	Wichita Fa Tex.
U. S. Government	6		10,000	848,146	U. S. Heliu Plant

oline absorption plants on natural gas lines in the district having a daily capacity of 357 million cubic feet.

Not all plants are now operated at capacity. Because of the decline of flush oil production, and proration of oil properties, the casinghead plants operated at only 4/5 of their rated capacities during 1931. Gasoline recovery plants on natural gas transmission lines operate according to gas passed through the pipe lines.

Carbon Black

The large quantities of casinghead gas being produced from the oil wells in the Texas Panhandle created a favorable condition for the manufacture of carbon black. During the early development of drilling wells the gas was blown into the air and wasted. Gasoline extraction plants were soon erected to extract the gasoline from this casinghead gas. The residue from the casinghead plants was used for fuel

Table VII

Casinghead Gasoline Plants in Texas Panhandle

County	Number of Plants	Daily Capacity in Gallons	Estimated Daily Capacity Thousand Cu. Ft. Gas
Carson	9	86,000	177,000
Gray	19	522,500	558,000
Hutchinson	18	386,500	610,000
Moore	1	3,500	9,000
Wheeler	3	30,000	53,000
Total	50	1,028,500	1,407,000

Line Gasoline Plants (Dry Gas)

County	Number of Plants	Daily Capacity in Gallons	Estimated Daily Capacity Thousand Cu. Ft. Gas
Wheeler	1	15,000	40,000
Potter	2	20,000	50,000
Moore	1	30,000	75,000
Hutchinson	1	75,000	192,000
Total	5	140,000	357,000

Table VIII

Gasoline Produced in Texas Panhandle

Year	Gallons	Estimated Total Thousand Cu. Ft. Gas
1926	13,209,047	35,600,000
1927	97,105,711	269,500,000
1928	123,900,155	343,300,000
1929	206,885,321	419,700,000
1930	317,733,716	439,600,000
9131	270,260,000	374,700,000
1932	226,779,672	352,887,000
Total	1,255,873,622	2,235,287,000

on the leases, but this required only a small fraction of the total. In September, 1926, the first residue gas was burned for the manufacture of carbon black. The carbon industry continued expansion during 1927, 1928, and 1929. The greatest construction program was during 1928. No new plants were built during 1931.

With the close of 1929 the production of carbon black had become equally as important, in the Texas Panhandle, as the production of oil and casinghead gasoline. At the close of 1930 there were 25 carbon plants in the Texas Panhandle with a combined daily capacity of 862,700 pounds of carbon black and capable of burning approximately 567,765,000 cubic feet of gas per day.

Carbon black plants in the Texas Panhandle comprise 58 per cent of the total capacity of all plants in the United States. In 1930 the Texas Panhandle plants produced 67.7 per cent of the total output of carbon black in the United States. About 1.5 pounds of carbon black are produced from 1,000 cubic feet of gas. Practically all of the plants are of the channel type. Only residue gas from casinghead gasoline plants is used in making carbon black.

Composition and Properties

The composition of natural gas in the Panhandle fields varies to some extent according to the reservoir and locality. Table X shows representative analyses.

Table IX

Carbon Black Plants in Texas Panhandle

Counties	Number of Plants	Daily Capacity in Pounds
Carson	2	86,800
Gray	8	301,400
Hutchinson	12	450,500
Wheeler	3	24,000
Total	25	862,700

Carbon Black Production in Texas Panhandle

Year	Pounds Made	Estimated Amount of Gas Used in Thousand Cu. Ft.
1926	2,566,000	1,890,000
1927	15,791,000	11,280,000
1928	60,228,000	43,020,000
1929	199,104,000	136,374,000
1930	254,844,000	168,104,000
1931	186,600,000	120,387,000
1932	177,812,000	118,591,000
Total	896,945,000	599,646,000

There are "sour" and "sweet" gases in the Texas Panhandle district. "Sour" gas is found largely in the line producing areas of the Borger district. "Sour" gas is also produced by some wells in Gray, Moore, Carson, and Potter counties. A "sour" gas contains from 5 to 200 grains of hydrogen sulphide per 100 cubic feet; a "sweet" gas contains 5 or less grains of hydrogen sulphide. Chemists state that most of the sulphur in the gas from the Granite wash zone is in the form of ethyl, prophyl, and butyl mercaptans rather than hydrogen sulphide. No "sour" gas is being taken by the pipe lines at this time.

The gasoline content of "lean" gas produced in the strictly gas areas of the Texas Panhandle varies somewhat. In general it can be stated that the lower a well is located on the north flank and the closer a well is to the oil-bearing areas, the higher the gasoline content of the gas. Natural gas

delivered to transmission pipe lines in the Panhandle district has an average gasoline content of 0.33 gallon per 1,000 cubic feet of gas.

Table X

Analysis of Panhandle Gas

	Composite Samples Wheeler County		Gas Well Carson County	Composite Sample Casinghead Gas, Gray County
	No. 1	No. 2		
Oxygen	0.22	0.40	0.40	
Carbon dioxide	0.00	0.10	0.30	
Nitrogen	1.59	2.10	1.80	
Methane	92.30	91.25	90.58	89.02
Ethane	3.09	2.80	3.70	4.02
Propane	1.81	2.09	1.37	4.20
Butane	.93	.82	1.08	2.90
Pentanes and heavier	.56	.44	.57	1.86
Gasoline content GPM	.329	.307	.342	1.068

The gasoline content of casinghead gas varies greatly, and seems to be partially reflected by the gas-oil ratio. The average gasoline content is about 0.75 gallon per 1,000 cubic feet. It ranges from 0.36 gallon to 2.00 gallons per 1,000 cubic feet.

Natural gas from reservoirs on the Bush dome in Potter County contains 2 per cent helium. This gas is treated at the United States Bureau of Mines helium plant for the recovery of helium.

Gas-Oil Ratio

Oil wells in the Panhandle have no uniform gas-oil ratio. The oil wells produce varying quantities of gas with the oil depending upon casing points and whether the gas strata are in contact with or separate from the oil strata.

Gas-oil ratios vary from 500 cubic feet of gas per barrel of oil to more than one million cubic feet of gas per barrel of oil. Data compiled in 1930 gave the western part of the Texas Panhandle fields a ratio of 29,450 cubic feet of gas per barrel of oil and the eastern part of the field a ratio of 9,780 cubic feet per barrel of oil. Average figures for such

a large area may be in error. We do not feel that an average gas-oil ratio can be applied to the entire producing area or even to individual pools.

Water

Surface water is generally encountered in the first 200 feet of formations drilled. Several other water-bearing horizons are encountered at various depths above the pay zones, depending on the location of the well. The first water-bearing horizon is encountered about 300-400 feet above the top of salt, and the second either in the top of salt or immediately above. No water is encountered from this last point to the oil bearing horizons unless it is pocket water, but water is uniformly encountered at sea-level depths. This lower water is known as bottom or edge water and is encountered around the edge of the oil-producing area. Where encountered about sea level the reservoir yields water freely when penetrated. It is a saline water high in chlorides and also contains some sulphates.

Status

There is an oil-water contact in the oil-producing areas along the north flank of the Amarillo structure and a gas-water contact exists along the west and south edges of the field. This was the original status when drilling began and only the oil-producing areas have been seriously affected by water encroachment and coning. Very little lateral encroachment has occurred except in areas depleted of oil and gas. Coning is the greater trouble in the oil areas due to too rapid withdrawals of gas and oil. There being no bottom water present high on the structure in the gas-producing zones, no encroachment and coning of water can occur as a result of rapid withdrawals and thus cause reduction of pressure.

The water level occurs in each producing stratum at or near sea-level.

Testimony of Harry F. Stevens

Available Reserves Under Present Canadian River Wells

Commission Counsel introduced testimony through Harry F. Stevens, Commission Engineer, with respect to the available reserves under present Canadian River wells.

Mr. Stevens is employed by the Federal Power Commission at Washington, D. C. in the capacity of Associate Engineer, and has been so employed since May 16, 1939. He stated his qualifications (Vol. 53, pp. 7366-7370) as follows:

"My college education consisted of three years at the United States Naval Academy, Annapolis, Maryland, and two years at the Colorado School of Mines, Golden, Colorado. I graduated from the latter in 1923 with a degree in Petroleum Engineering.

"My first employment after graduation, starting in June 1923, was with the Empire Oil & Refining Company at Bartlesville, Oklahoma, as a Junior Engineer. The plan of the Junior Engineering course was to provide experience in various branches of the oil and gas industry. My experience on this course consisted of assignments to various activities described briefly as follows:

"1. Keeping time and costs on a gas pipe line construction job in Kansas.

"2. Keeping time and cost on extension of city distribution system in Arkansas City, Kansas

"3. In charge of construction of a small oil pipe line near Cushing, Oklahoma. In addition to supervision, the work included the keeping of time and progress sheets, the book work related to the job, and testing of the line.

"4. Refinery assignments, Tulsa and Cushing, Oklahoma.

"5. General lease production work in the El Dorado field, Kansas.

"In June 1924, I was transferred to Henry L. Doherty Company, New York, where I remained until approximately March 1927. During this time, my work consisted principally

of statistical analysis and investigation of oil shale and oil shale processes.

"In March 1927, I was transferred to Empire Oil & Refining Company at Bartlesville, where for a year I was engaged in search and investigation of oil producing properties which might be repressured. Also during this year, I worked out a unit plan for production of oil and gas.

"In the first part of 1928, I was temporarily transferred to Cities Service Gas Company for the purpose of testing and reporting on the production of Missouri-Kansas Pipe Line Company. I was then permanently assigned to Cities Service Gas Company for the purpose of developing underground gas storage in depleted fields, for their system. During this period, extending to October 1936, I participated in every phase of this activity, from investigation through control of fields, testing of fields, and repair of wells to analysis of operation, and wrote approximately sixty engineering reports in connection with the work. During the work on gas storage, the company put into operation three gas storage projects at strategic points in its system for relief of peak load or emergency conditions. Its total capacity, I believe, was and now is the largest in the country for the purpose to which it is devoted. A fourth project was about to be put in operation at the time I left the employ of this company. During the period of work on gas storage, all methods of gas storage were investigated and reported. The analysis of gas storages dealt with inputs and withdrawals of gas and with the corresponding pressure changes, for the purpose of determining whether any gas was being lost from the structure. This analysis, each time it was done, constituted essentially an estimate of reserves. In the latter part of the period with Cities Service Gas Company I also made the monthly production report for the company.

"The companies listed in the foregoing covering experience from June 1923 to October 1936, were subsidiary companies of Cities Service Company, except Henry L. Doherty & Company, which was a management company for other Doherty interests.

"In October 1936 I went with Stanolind Oil & Gas Company, Tulsa, Oklahoma, as a Petroleum Engineer. My

work with this company consisted of preparation of engineering reports on petroleum engineering problems, described briefly as follows:

"1. Geological and engineering study of salt domes;

"2. Investigation of and recommendations for solution of current production problems from both physical and economic points of view;

"3. Recommendations for development, from both physical and economic points of view;

"4. Analysis of reports from field offices, and recommendations thereon;

"5. Analysis of well spacing problem—siliceous lime fields of Kansas;

"6. Investigation of and proposals for development of new oil fields with respect to economics of unitized development and to conservation of resources;

"7. Analysis of the unit principle of development with respect to equity of all parties concerned;

"8. Repressuring investigation of a Permian lime oil field, Texas;

"9. Proposals on exploitation of new markets for oil products.

"From May 16, 1939 to the present time I have been employed by the Federal Power Commission as Associate Engineer. My duties for this period include the following:

"1. Collection of the equivalent of approximately 30,000 pages of data on the Panhandle Texas gas fields, covering approximately six months;"

This parenthetically is the same work referred to by Mr. Hammer in his discussion of experience. We were both on that assignment.

"2. Discussion with representatives of numerous companies concerning various problems relating to the Panhandle gas field;

"3. Analysis of Panhandle field data, and preparation

of exhibits for the current hearings involving the Canadian River Gas Company and the other companies involved."

Q. Mr. Stevens, in connection with your qualifications, the last paragraph on Page 1 and continuing to Page 2, where you refer to your work in connection with the study of underground storage, where you speak of the storage gas, do you mean underground storage?
A. Yes.
Q. In natural reservoirs?
A. Yes.
Q. That work is still being carried on?
A. Yes, it is. They are using those projects.
Q. Of course, in your qualifications you spoke of storage and I want it clearly understood that it is underground storage of gas in natural reservoirs.
A. That is right.

Mr. Stevens prepared and submitted Exhibit 182, and testified with respect thereto (Vol. 53, pp. 7371-7386) as follows:

Q. I will ask you whether you have prepared an exhibit entitled "Estimate of Recoverable Gas Reserves"?
A. Yes.
Q. And when you speak of present wells, as of what time do you refer to?
A. I refer to December 31, 1939.
Q. Is this the exhibit I now show you?
A. Yes.

Mr. Lange: We would like to have this marked for identification.

The Trial Examiner: It will be marked for identification as Exhibit No. 182.

(Exhibit 182, Witness Stevens, marked for identification.)

By Mr. Lange:

Q. Mr. Stevens, will you turn to Exhibit No. 182, turning to the first page in that exhibit where you have included a written statement?
A. Yes.
Q. Will you read that statement into the record?
A. "This exhibit is prepared for the purpose of esti-

mating the reserves of gas that will be recovered by Canadian River Gas Company from their present wells, as differentiated from recoverable reserves under leases, the latter to be recovered by present wells plus future development.

"Recoverable reserves are estimated on production data for the last four years and pressure data for the last five years. In the matter of pressure, the 1935 pressure is, of course, the pressure point at which the 1936 production begins. The reason for adopting production data and related pressure data for the last four years is that for this period field data are considered to be the most dependable. The pressures are mid-year pressures taken by the Railroad Commission of Texas, and the production figures are for the year ending July 31, comparable to the time at which the pressures were taken.

"A general reason for considering the production and pressures of the total quadrants of which Canadian River wells have a part, is that in projecting into the future some weight is given to the interrelation of factors affecting production for any given part of the wells, such as the Canadian River wells.

"Recoverable reserves have been estimated by quadrants, the same method being used for all quadrants. The method is described as follows:

"1. The production for the total quadrant is accumulated by years for the last four years and plotted against corresponding pressures. The 1935 pressure is plotted against zero production. Through the points so plotted is drawn the mean curve which is extended to intersect a line drawn through the assumed abandonment pressure of 25 pounds gauge at the well head.

"2. The reading of this intersection on the horizontal scale is the estimated recoverable reserves for the quadrant as of July 31, 1935.

"3. To obtain the recoverable reserves for the wells as of July 31, 1939, we subtract the production for the period of July 31, 1935 to July 31, 1939, giving the future expectancy for the latter date.

"4. After consideration of the ratio of Canadian River well production to the total quadrant production, it was found that the overall ratio existing for the year 1939 was approximately the same as if the period of the last three years was considered. In any event it would appear that the 1939 ratio should be given major weight in determining what proportionality should be assumed for the future. The ratio of Canadian River production to total quadrant production was then assumed as that ratio which could be expected for the future on the premise that they would continue to capture that proportion of the recoverable reserves of the quadrant. This ratio was calculated from the two production data columns on the left side of the tabulation.

"5. The recoverable reserves, or future expectancy, of the quadrant was then multiplied by the ratio calculated as described, to obtain that share of the quadrant recoverable reserves that will be produced by the present wells of the Canadian River Gas Company. The curve showing the Canadian River recoverable reserves is drawn starting at zero, to provide direct reading without subtraction of any production. Any point o the Canadian River curve can be confirmed by applying the ratio to the value of a similar point on the quadrant curve after the quadrant production is subtracted.

"The quadrant reserves are totaled and shown at the bottom of the tabulation.

"A curve showing the composite recoverable reserve, or future expectancy, of all the Canadian River wells is included along with the quadrant curves.

"It will be noted that in the case of every quadant, the mean through the plotted points is drawn conservatively.

"That is, it would have been easily possible within the bounds of reasonableness to drawn our mean at a gentler slope, which would result in its intersection with the 25-pound line at a higher reading for recoverable reserves.

"The analysis carried out as described summarizes to the following conclusions:

"1. Recoverable reserves under present Canadian River wells, 2,186.7 billions of cubic feet. (14.65 pounds.)

"These recoverable reserves are as of July 31, 1939.

Three new wells have been drilled between this date and December 31, 1939. These wells have no production record on which to base an expectancy; therefore, they are estimated on the basis of the 91 wells operating as of July 31, 1939.

"The recoverable reserves of the three new wells on this basis is 72.089 billions.

"Total recoverable reserve, December 31, 1939, including production for August 1, 1939, to December 31, 1939, 2,258.789 billions."

Q. In each instance you mean cubic feet of gas?
A. Yes.

"Less Canadian River production August 1, 1939, to December 31, 1939, 19.940 billions.

"2. Total Canadian River recoverable reserves, December 31, 1939, 2,238.849 billions.

"The tabulations and curve sheets constituting part of this exhibit are listed below:

"Tabulation—Estimate of Recoverable Reserves.

"One curve sheet showing plotting and extrapolation of data for summation of the quadrants in which Canadian River Gas Company has production.

"Nine curve sheets showing plotting and extrapolation of data by individual quadrants.

"Each of the curve sheets includes a curve for the Canadian River wells alone."

Q. Now turn to the first curve sheet following this written statement, Mr. Stevens, and briefly explain it.
A. The group of two curves shows first the extrapolated production pressure plottings of all of the wells in all of the quadrants in which Canadian River Gas Company has wells. The solid curve is the curve for those total wells; the dashed line is the curve for Canadian River's share alone; the circled points represent the plotting referred to of accumulated production for the four years ending July 31st, 1939, against corresponding pressures for those years, the pressure data and the production data are mid-year

data; that is, for the year ending July 31st for the years in question.

Q. Now, you have following that the nine curve sheets referred to in your written statement. Can you give a brief explanation of all of those and the purport of those curves?

A. All of these curves comprising the nine curve sheets are calculated and plotted in the same manner. I will explain the first one. It is also illustrative of the other eight curves.

This curve sheet—the curves thereon are plotted and the data accumulated in exactly the same manner described for the composite curve with the exception that it refers to Carson County, Quadrant 4. That factor which you see at the top center of the page is repeated on all of them and is the ratio of Canadian River Gas Company's production in 1939 to the total quadrant production for that same year. That represents the relation between the dashed curve of Canadian River Gas Company alone to the total quadrant curve which is shown in solid.

Q. Did you proceed in the same fashion in the construction of the following curves? Maybe you had better explain the next one.

A. They were drawn in the same manner.

The next one is for Hartley County, Quadrant 1, that being the only quadrant in Hartley County. This curve presents a little different appearance than the other in that it has several lines back and forth across the page which is simply a method of parallel projection which will be evident upon inspection. You will notice in this case the dashed line representing Canadian River Gas Company's wells alone is parallel to the solid line, whereas in other cases it is not. The reason for that is that Canadian River Gas Company has all the wells in that quadrant and the factor is one.

After that first curve was drawn it would have been possible to leave it there without drawing the dashed curve, but it would have been necessary to subtract the accumulated production through 1939 from any total reading that you would read at the intersection of the 25-pound line. And the purpose in this case of drawing the dashed line was simply this, that by starting it at zero whatever reading is

read at the intersection of the 25-pound line is the reading of the recoverable reserve direct and does not require any subtraction of accumulative production through 1939.

Q. Now, the next curve sheet refers to the Hutchinson County Quadrant 3.

A. Yes.

Q. Will you read the description of that and its purport?

A. That refers, as indicated, to the third quadrant in Hutchinson County. It is of the same general nature as the other curves which have already been described. This sheet has a radically different pattern than the one described for Hartley County. You will notice the lack of parallelism between the dashed curve and the solid line; the reason for that is that Canadian River Gas Company's production in relation to the quadrant reserve is not one. It only represents a portion of the quadrant production which as you will see in the top center of the page is 1167 of the Canadian River Gas Company's production to the quadrant production for 1939 which ratio was applied to the quadrant curve to obtain the Canadian River Gas Company's curve alone. By "Canadian River Gas Company's curve," I mean the curve for wells that the Canadian River has in Quadrant 3, Hutchinson County.

Q. Each of those curves as situated in the extension?

A. Yes, sir.

Q. Turn to your next curve, Moore County, Quadrant 1.

A. This curve was constructed in the same manner as the others. There is really nothing new to describe except possibly to note that each of these quadrants has a slightly different pattern relation between the Canadian River's curve and the total curve. That is entirely a matter of what the factor is, the ratio of Canadian River's production to the total quadrant production.

Q. And the next is Moore County, Quadrant 2.

A. That curve sheet was built up in the same manner as previously described. There is really nothing more to say about that except that it has been constructed in the same manner.

Q. Is there any particular explanation that you deem necessary with reference to the three remaining curve sheets in the exhibit?

A. No, there is nothing with respect to those three quadrants that should be mentioned.

Q. Turn to the typewritten table that appears following the curve sheet and explain the contents and import of that in connection with your exhibit.

A. The tabulation simply represents the summary of data used in plotting and constructing the curve already described. You will note that it is divided by the quadrants. These quadrants are the same area divisions as adopted for studies previously submitted in the exhibit presented by Mr. Hammer.

The method of obtaining this ratio of Canadian River's production to the total quadrant for the year 1939 is shown by the first two columns, one being the production for Canadian River Gas Company and one being for the total quadrant and a simple division gives you the ratio which is shown in the next to the last column.

Q. That is the column headed "Ratio: Canadian River Gas Company Production to Total Quadrant 1939"?

A. Yes, starting with .05933 and the next one is 1.000.

The third column of figures, excluding the dates, consists of accumulative total quadrant production for the year noted in the first column. That gives the figure to be plotted against the pressures which are shown in the next column to the right. There is the essential data on which the solid line curve is plotted.

Q. You are referring to your solid line curve preceding this table?

A. Yes, sir, that is right. The next two columns refer to the number of wells. Those figures contained therein represent the number of wells for the years in question, both as to Canadian River Gas Company and for the total quadrant.

The next column to the right, headed "Future Expectancy, 7-31-35," is the intersection of the curve drawn on the data previously described with the 25-pounds assumed abandonment pressure line. That figure includes all production which has been involved in the plotting of the curve. That production is shown in the next column to the right headed

"Withdrawals, Total Quadrant, for the four years in question."

It is then necessary to subtract that figure from the "Future Expectancy" which has to be done to arrive at the future expectancy as of 7-31-39. That is shown in the next column to the right. It is to this figure that we applied the ratio of Canadian River's production to the quadrant production for 1939, this ratio having been already calculated from the first two columns on the extreme left.

Multiplication of the "Future Expectancy" of total quadrants, 7-31-39, by this ratio gives the last column of figure shown in the tabulation or the futures expectancy of Canadian River Gas Company wells as of 7-31-39. Those totals, as you will see in the lower right-hand corner, amount to 2,186.7 billion cubic feet. It is from this 2,186.7 billion cubic feet that we proceed to the end of 1939.

As stated, that calculation was accomplished by taking the average of the 91 wells which simply means dividing 91 into 2,186.7 billion cubic feet and multiplying it by 3 for the new wells that were added in the latter part of 1939, which figure is 72.089 billion cubic feet.

Q. You are now relating that fact to the third page of your written statement?
A. That is right.

Mr. Lange: The pages are not numbered. They should be numbered.

The Trial Examiner: The reporter will make the changes.

By Mr. Lange:

Q. I think I interrupted you, Mr. Stevens.
A. I believe we were at the point of adding the expectancy of three new wells drilled in the latter part of 1939 which figure was obtained by multiplying the average expectancy of 91 wells by 3, constituting 72.089, which added to the expectancy as of 7-31-39 gives 2,258.789 billions as of 12-31-39, but including the production for the year, including the production for that part of the year between August 1, 1939 and December 31, 1939 in the amount of 19.940 billions cubic feet.

Of the previously stated expectancy that is the amount that has already been used up by production, and, consequently has to be subtracted. That subtraction gives you 2,238.849 billion cubic feet which is the total of Canadian River Gas Company's recoverable reserves as of December 31, 1939.

Q. Recoverable reserves of gas?
A. Yes.
Q. As of December 31, 1939?
A. Yes.
Q. Now, in connection with this study, Mr. Stevens, I will ask you whether subsequent to the preparation of Exhibit 182 you prepared a page supplementing the study down through December 31, 1940.
A. Yes, I have.

Mr. Lange: I suggest, Mr. Examiner, that this document be marked for identification as Exhibit No. 182-A.

The Trial Examiner: It will be so marked.

(Exhibit 182-A, Witness Stevens, marked for identification.)

By Mr. Lange:

Q. Now, Mr. Stevens, will you please read this supplemental page identified as Exhibit No. 182-A into the record?
A. "Canadian River Gas Company, Supplement to Estimate of Recoverable Gas Reserves, Present Wells.

"The above named exhibit was confined to wells existing as of December 31, 1939."

Q. That refers to Exhibit 182?
A. Yes.

"Three new wells were drilled in 1940. The recoverable reserves or expectancy of these new wells should be added to that of the wells previously considered, as of December 31, 1939. The purpose of this supplement is to extend the scope of the estimate of recoverable reserves to December 31, 1940 by the addition of expectancy of the three new wells of 1940, followed by the subtraction of production from all wells during 1940.

"As the new wells have no production record on which to base a future expectancy, the expectancy of each will be considered to be the average of other Canadian River Gas Company wells. This assumption is considered very conservative, as the average capacity of the three wells is approximately 43 million cubic feet, which is more than twice the average capacity of the company's other wells.

"Total Canadian River recoverable reserves, December 31, 1939, 2,238,849 billions;

"Acreage recoverable reserve, 94 wells, December 31, 1939, 23,817,543 * * *."

Q. Shouldn't there be a period there between "23" and "817,543"?

A. If we are talking in billions, as these other figures are, the point is after the "23." It should read "23.817,543."

Q. Do you want to make that correction?

A. That is supposed to be a period.

Q. The period would be after the "23"?

A. Yes.

The Trial Examiner: There appears to be a period on my copy but perhaps the official copy may not show one. In any event, it will be corrected to correspond with the witness' testimony.

The Witness: "23.817,543 billions.

"Additional recoverable reserve, 3 new wells, 71.453 billions.

"Total Canadian River recoverable reserves, December 31, 1940, including production of all wells for 1940, 2,310.302 billions.

"Less Canadian River production, 1940, 49,000 billions.

"Total Canadian River recoverable reserves, December 31, 1940, 2,261.302 billions."

By Mr. Lange:

Q. Are there any further explanations you deem necessary in connection with this supplement?

A. I don't think so. It was calculated in the same manner from one date to the next—to the final date, the final

date being 12-31-40. It was calculated in the same manner as we went from 7-31-39 to 12-31-39. This procedure is necessary because before any new wells may be added in any interval for which there is no production, we must necessarily consider those new wells to be of average expectancies since they have no production record upon which expectancy can be predicted.

Mr. Lange: That is all for the present.

The Trial Examiner: Mr. Stevens, just to make this record a little clearer here, going back to that figure we were just discussing, there appears to be a comma between 7 and 5. That comma should be stricken out, shouldn't it?

The Witness: Well, to make it correct mathematically, it should be stricken; however, if the decimal is firmly established after 23, it sufficiently identifies the figure.

Mr. Spencer: You are carrying out the decimal point to six places?

The Witness: We did there. It isn't essential and—

Mr. Spencer: But you do that here—carry it out six places?

The Witness: Yes.

The Trial Examiner: I think that is understandable, then.

Mr. Lange: I think that is all for the present.

Mr. Stevens further testified (Vol. 62, pp. 8690-8697) as follows:

Mr. March: Mr. Examiner, in checking over the record we found that Mr. Stevens left out one essential explanation in his exhibit that he should have given on direct, and an explanation that we failed to ask him about. I might ask him that question with Mr. Keffer's consent at this time.

Mr. Keffer: All right.

Voir Dire Examination.

By Mr. March:

Q. Mr. Stevens, did you use the same quadrants in

figuring the reserves under wells of Canadian River's acreage as did Mr. Hammer?

A. In general, yes, and with one exception.

Q. You mean in general, with just one exception?

A. With one exception.

Q. What quadrant was that?

A. That was the Quadrant 3, Hutchinson County.

Q. Just how does your treatment of that quadrant so far as that is concerned differ from Mr. Hammer's? Just what portion of the quadrant do you not include in your exhibit, your calculations—in what portion of the quadrant?

A. Hutchinson Quadrant 3 is a long quadrant vertically laid out on the map, and the Canadian River's wells are in the southwest portion of that, and principally for that reason consideration was made of that part of the quadrant adjacent to and inclusive of Canadian River's wells, and that part of the quadrant so described was taken as the quadrant. In other words, it was really a new areal designation for Quadrant 3 with respect to Canadian River's wells.

Q. Because Canadian River's wells were not in the northern part of the quadrant?

A. That is right.

Q. And were confined to an area in more or less the southern or southwestern part of the quadrant?

A. Yes.

Q. You will have to read for the record just exactly the wells listed in your working papers you did take in that quadrant.

A. Those wells are as follows: Johnson A-1; Bivins B-1; Bivins B-2; Bivins B-4; Dunaway A-1; Bivins B-5; Bivins B-6; Bivins F-1; Bost A-1 and Bost B-1—

Mr. Spencer: Can I interrupt you a minute?

Mr. March: Yes.

Mr. Spencer: Those are all Canadian River's wells you have read into the record so far?

The Witness: Yes, they are, that I have read so far.

Mr. Spencer: When you come to wells that are not Canadian River's wells, will you so indicate so we can get

a list of those? We know our own wells but we don't know the other wells that you have.

The Witness: Dunaway B-1, Dunaway A-2. That is all.

Mr. March: Those are all of the wells in that quadrant you utilized?

The Witness: Yes.

Mr. Spencer: Do I understand you have used no wells except Canadian River wells?

The Witness: I have used no wells but Canadian River wells.

By Mr. March:

Q. Did you designate the approximate location of those wells—you have already done that?

A. I have already done that. However, it should be pointed out that in determining the ratio to be applied we did consider the ratio production in terms of the entire quadrant which amounts to .1167 fully finished. Those things as described are the essential differences from the areal designation of Quadrant 3 on the maps.

Mr. March: Mr. Examiner, I unthoughtedly proceeded without renewing our offer of Mr. Hammer's exhibits, which was to be acted upon this morning. We renew the offer of those Exhibits 179, 180 and 191.

The Trial Examiner: Let's get through with Mr. Stevens first.

Mr. March: It will probably take all day. We want to get rid of Mr. Hammer's exhibits.

Mr. Spencer: I would like to ask him a few questions about the very thing you have injected for the moment.

Mr. March: Mr. Examiner, do I understand that the Examiner is not going to rule on Mr. Hammer's exhibit today?

The Trial Examiner: Well, let's go along with Mr. Stevens and see how we get along. I would like to have all of this in one place in the record if possible.

Mr. Spencer: As a matter of fact, I think that might expedite the whole procedure because whatever objections we have will be aplicable to both exhibits taken at the same tme.

Mr. March: There is no relation as to the two exhibits. We don't think it will expedite things a bit. If that is satisfactory to the Examiner it will be satisfactory to us.

Cross Examination (Continued).

By Mr. Spencer:

Q. Mr. Stevens, you used only Canadian River's wells in computing reserves, is that the distinction you made here? You use all of the wells or production in determining the ratio and for determining reserves under Canadian River's wells?

A. There are some other wells in there. I didn't read the complete list here. On my next page is a recapitulation which does include the other wells. This tabulation here is only for Canadian River production and there are some other wells which I should add to that of other companies.

Q. Will you read those slowly so we can write them down?

A. Yes.

Mr. March: I will say, Mr. Spencer, when we went over this last night we didn't have the working papers to check it as we should have.

Mr. Spencer: That is all right.

The Witness: These are the additional wells of other companies: Phillips N. R. Johnson No. 1—

By Mr. Spencer:

Q. All right.

A. Texoma Johnson A-1-G; Panhandle Bost 1-9—that is Panhandle Eastern—Panhandle Bost 114; Panhandle Bivins 91; Texoma C. Johnson 1-P; Texoma Johnson 1; Phillips Claire 1; Danube Wheatley Johnson 1; Huber Crudgington No. 1—

Q. What was the last one?

A. Huber Crudgington No. 1

A. Yes. Huber Dunaway 1; Phillips Sanford A1; Phillips Sanford No. 1; Phillips Yantes No. 1—

Q. I beg your pardon?

A. Phillips Yantes No. 1.

Q. All right.

A. Huber Dunaway No. 2; Phillips Burl No. 1; Phillips Eddy No. 1; Phillips Fromma No. 1; Phillips H. E. Johnson No. 1; Sinclair Prairie Johnson 1-D; Phillips Snow No. 3; Texoma Deahl 1-E.

Q. Is that all, Mr. Stevens?

A. That is all in that area combined with the previously stated Canadian River wells.

Q. That gives you a total of how many wells that you used in that quadrant?

A. 35.

Q. And out of that how many belonged to Canadian River?

A. 13.

Mr. Spencer: We find a total of 34 but perhaps we missed one. We can check that with you later. It doesn't need to be done now.

The Witness: Well, now it is possible that I have 34.

Mr. Spencer: Well, we can check that later. It is just a difference of one well. We can check it with your working papers to see whether we have them all.

Mr. Examiner, I wonder if we could get Mr. Hammer's quadrant map back up on the board again?

The Trial Examiner: Let's see. That is Exhibit 180, is it not?

Mr. Spencer: Exhibit 180.

The Trial Examiner: All right, we will do that.

By Mr. Keffer:

Q. On Quadrant 3, Hutchinson County, Mr. Stevens, I believe you just stated that you considered only 35 wells in the area, is that right?

A. Yes, sir.

A. I don't recall that.

Q. You know it is more than 35, don't you?

A. Yes, sir, it is a considerable distance from this area.

Q. Would you hazard a guess that there are as many a hundred wells?

A. I wouldn't hazard a guess, but it may be more less.

Q. I wonder if your working papers won't reflect th wells that you eliminated?

A. I have, I think, a list of those wells here in th working papers; however, it is immaterial to the problem The reason they were not considered—

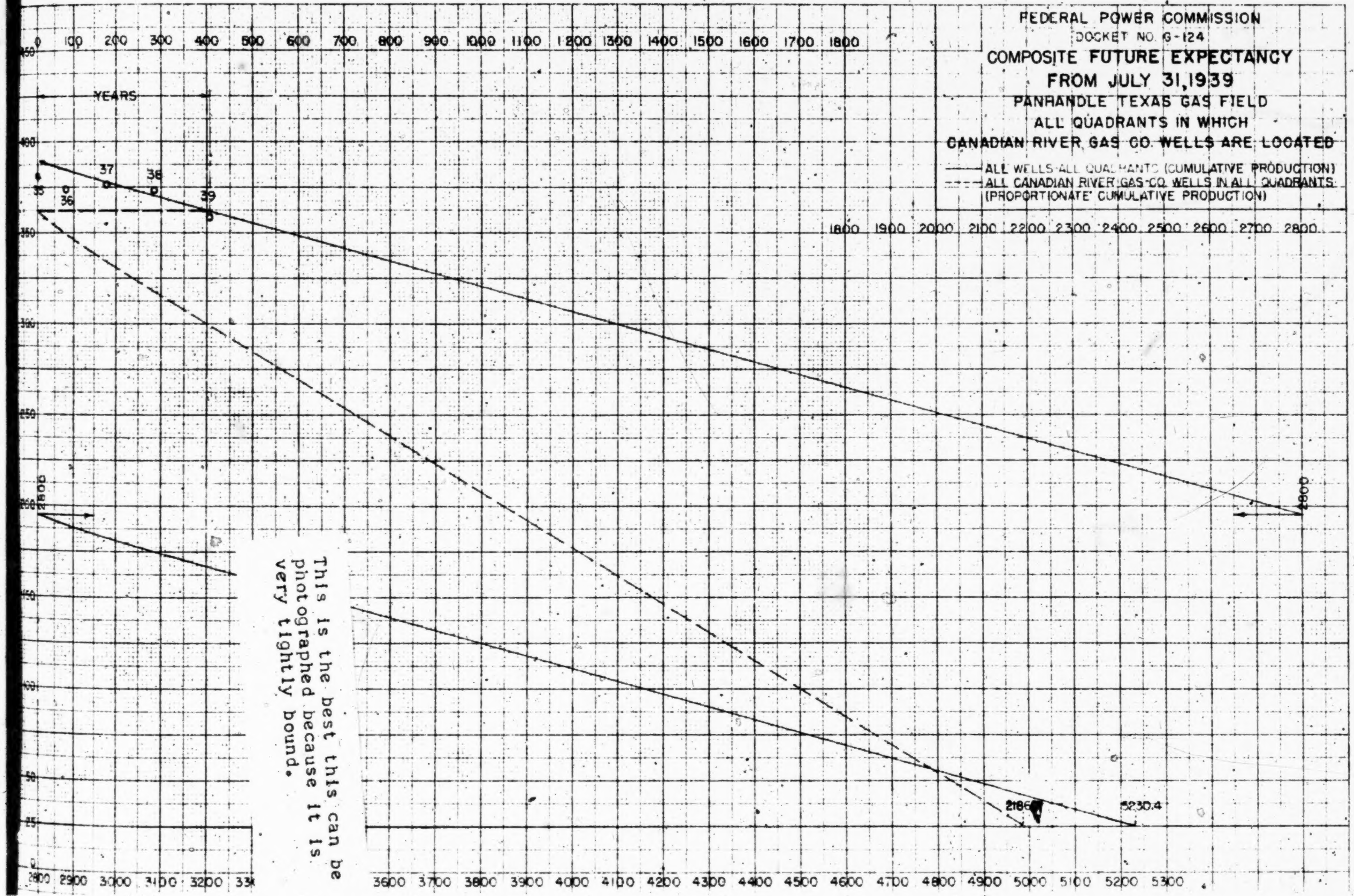
Q. That wasn't my question. I want to know ho many wells are in the area, or in the quadrant as a whol as compared to the number of wells you actually used.

A. I don't recall that from memory.

Q. I am wondering if you couldn't get that figure fro your working papers.

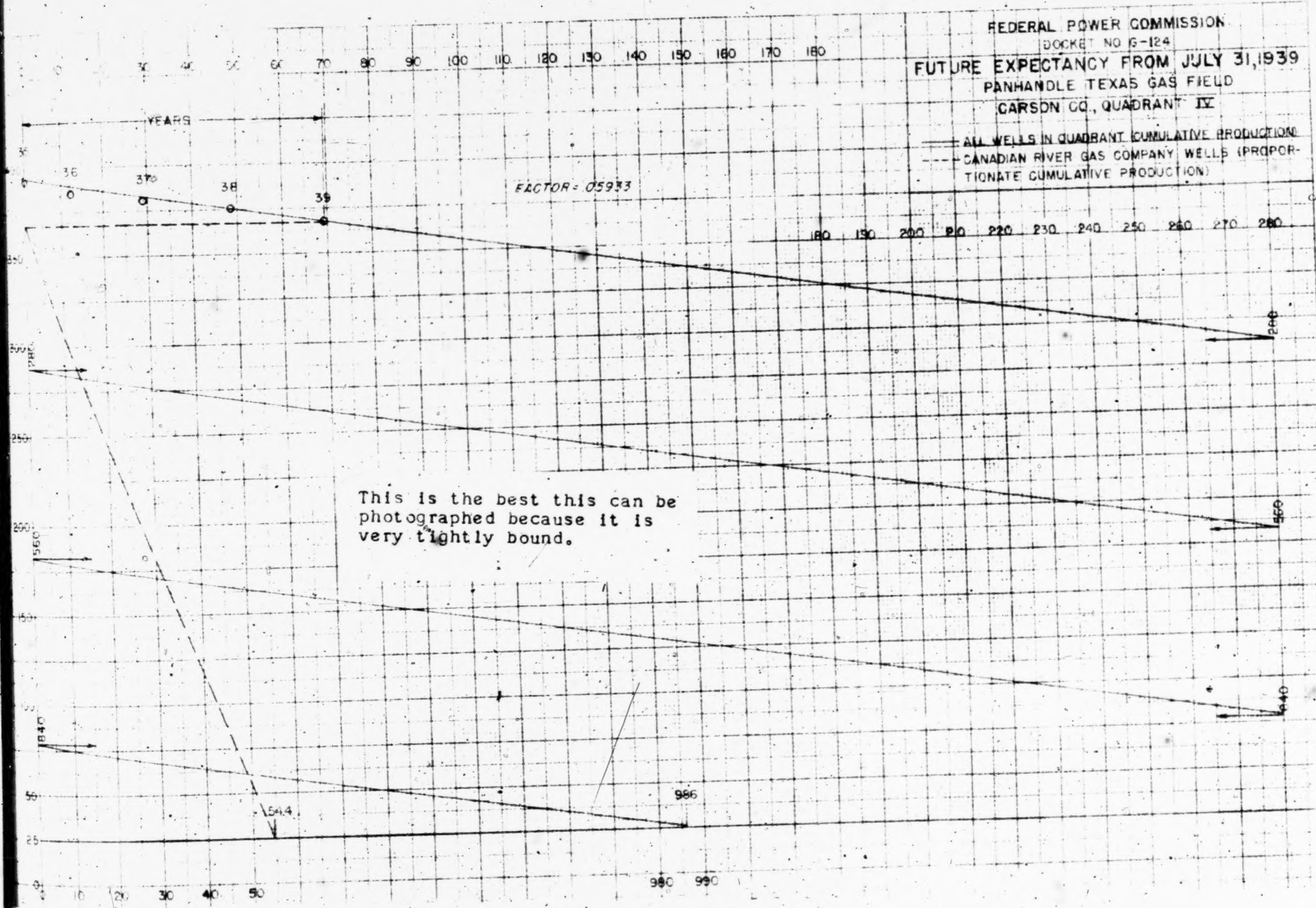
A. I think I possibly could.

Exhibit No. 182



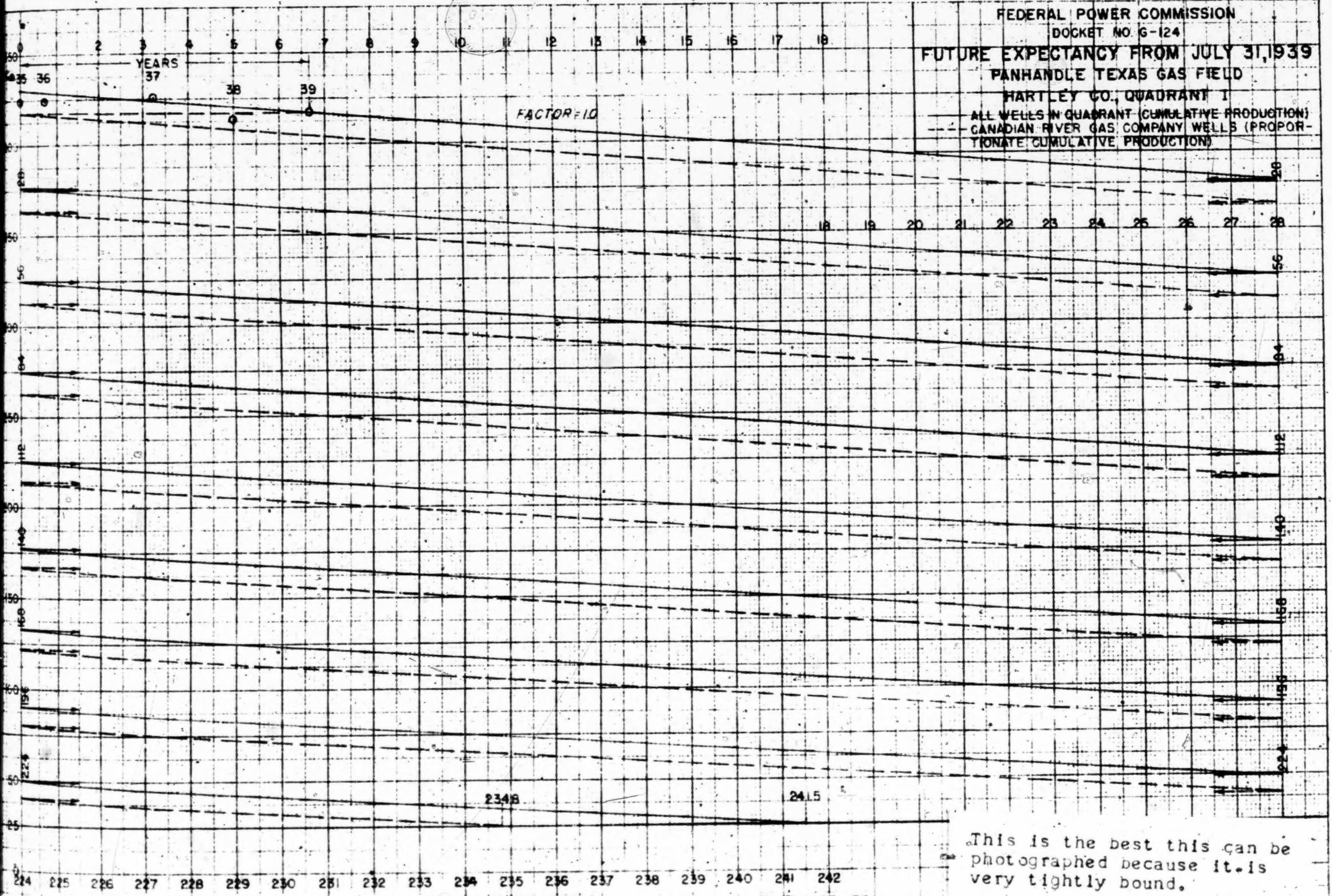
This is the best this can be photographed because it is very tightly bound.

Exhibit No. 182



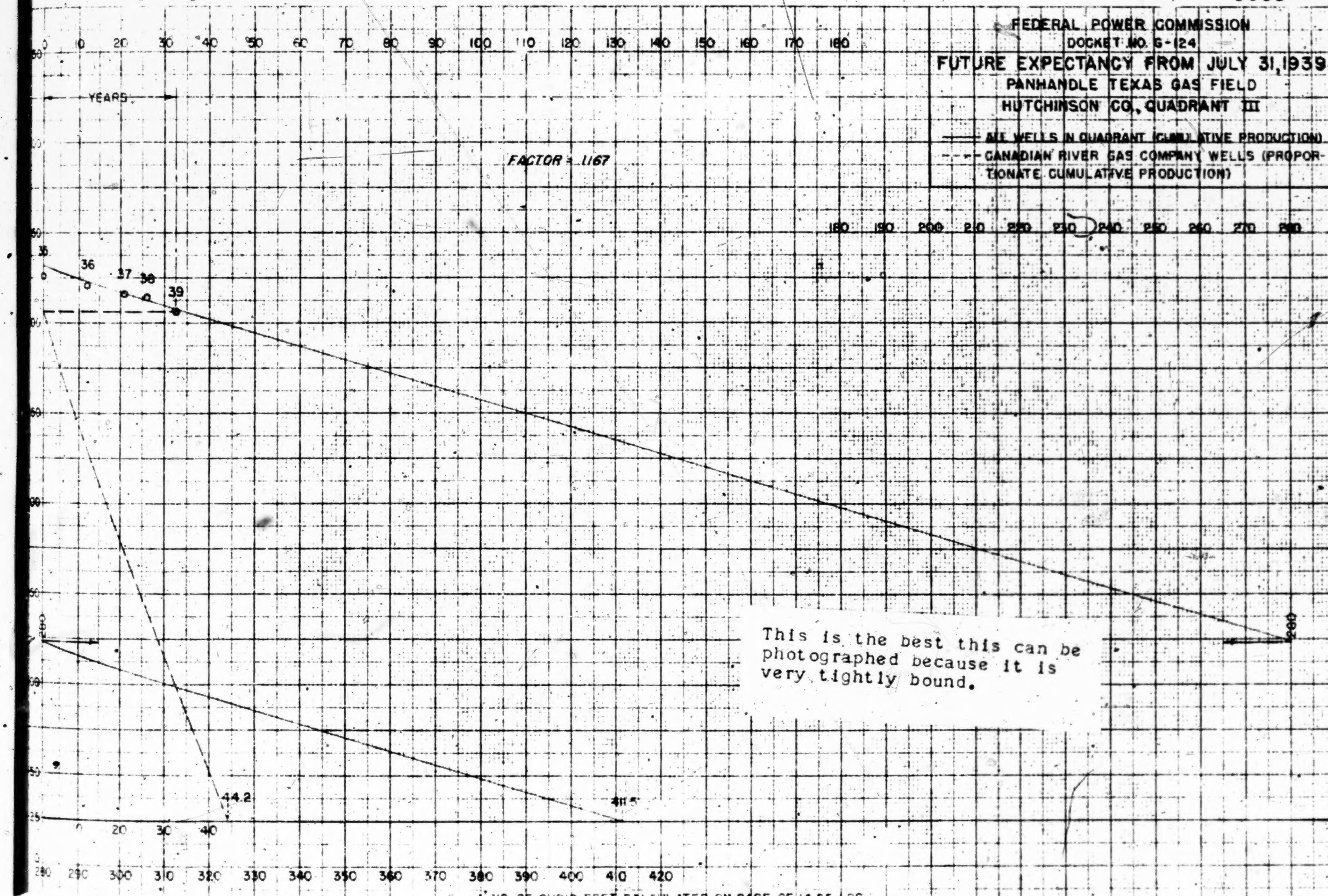
This is the best this can be photographed because it is very tightly bound.

Exhibit No. 162 5057



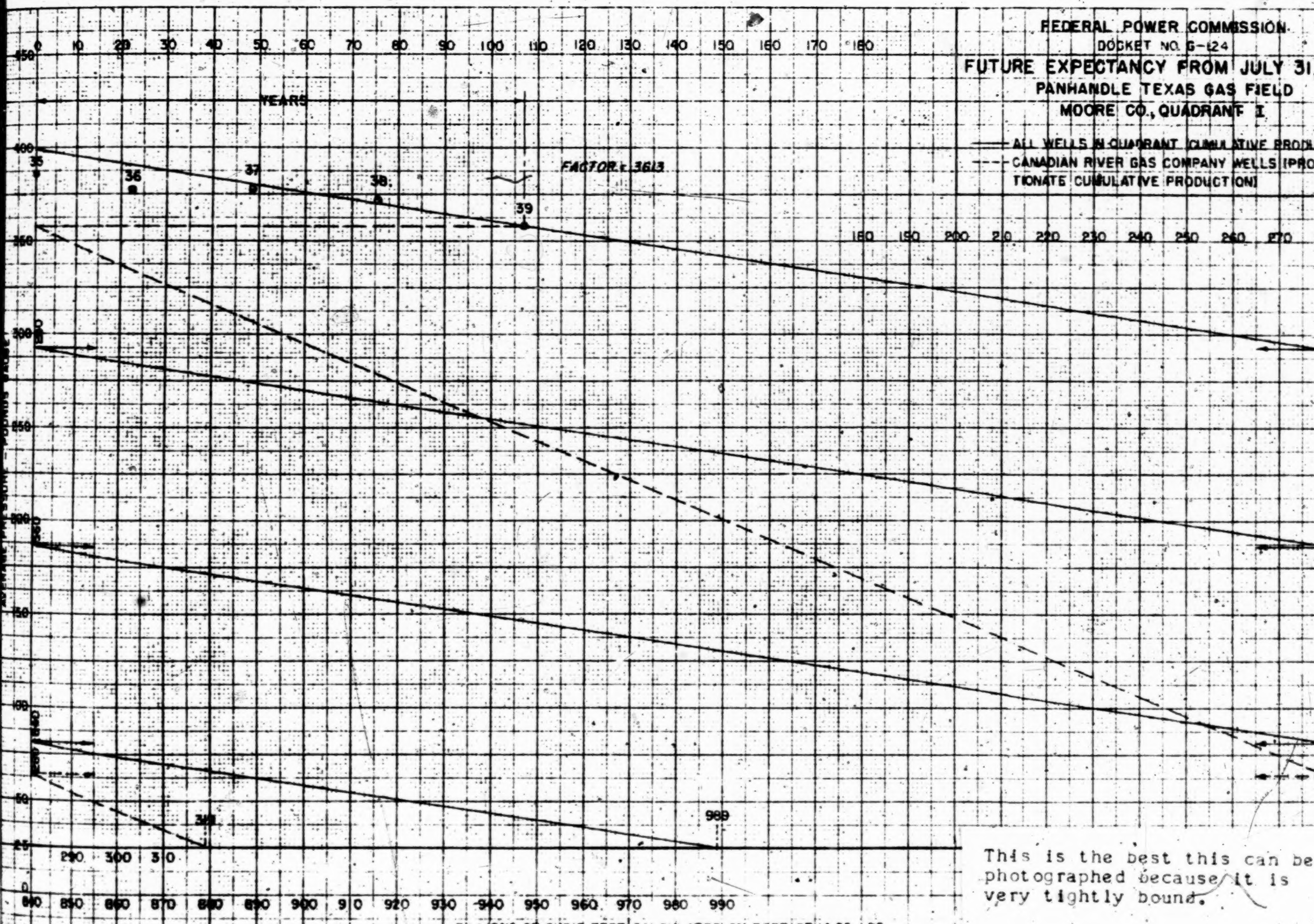
This is the best this can be photographed because it is very tightly bound.

Exhibit No. 182 15058



This is the best this can be photographed because it is very tightly bound.

Exhibit No. 182 1502



This is the best this can be photographed because it is very tightly bound.

Exhibit No. 132

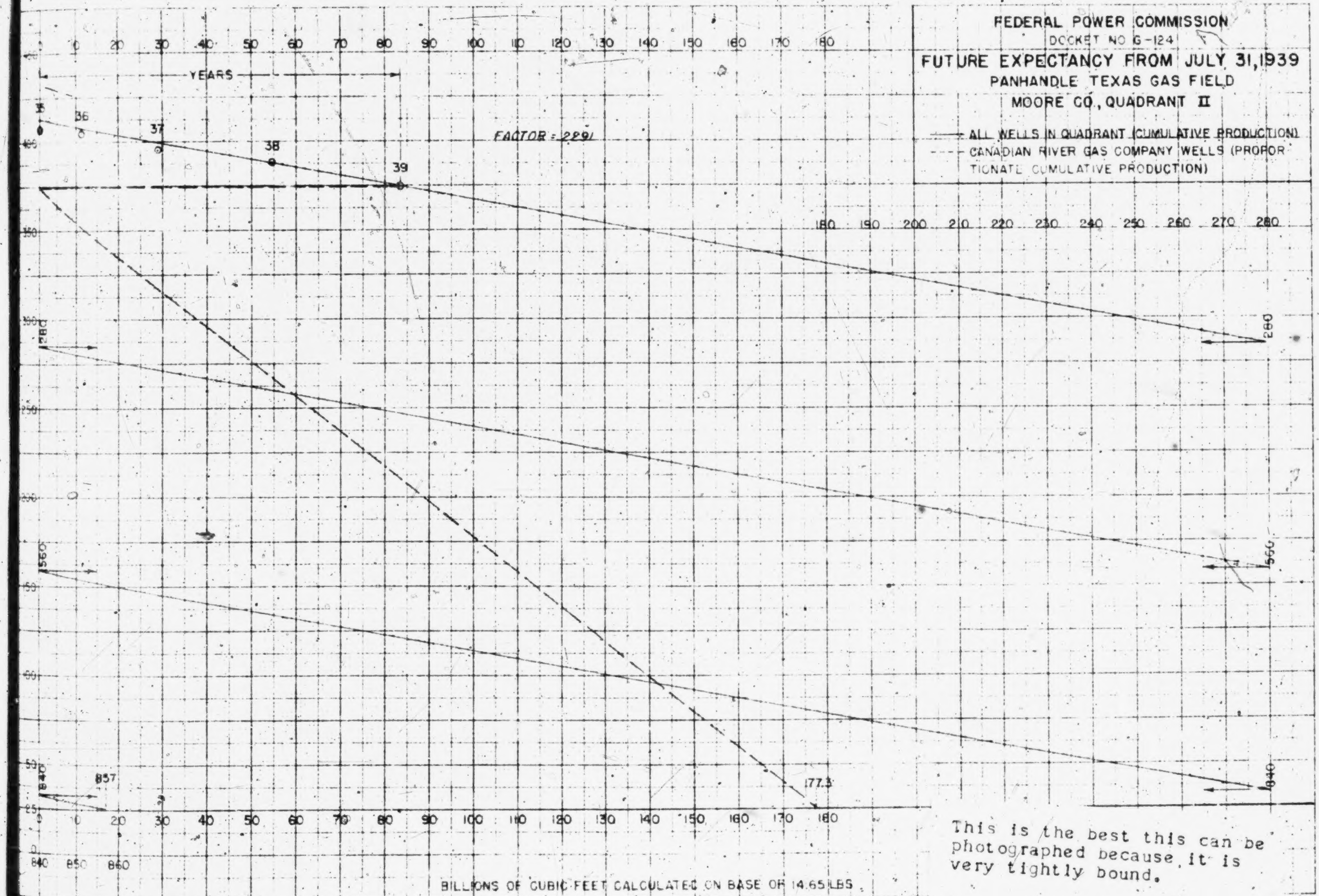


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Exhibit No.

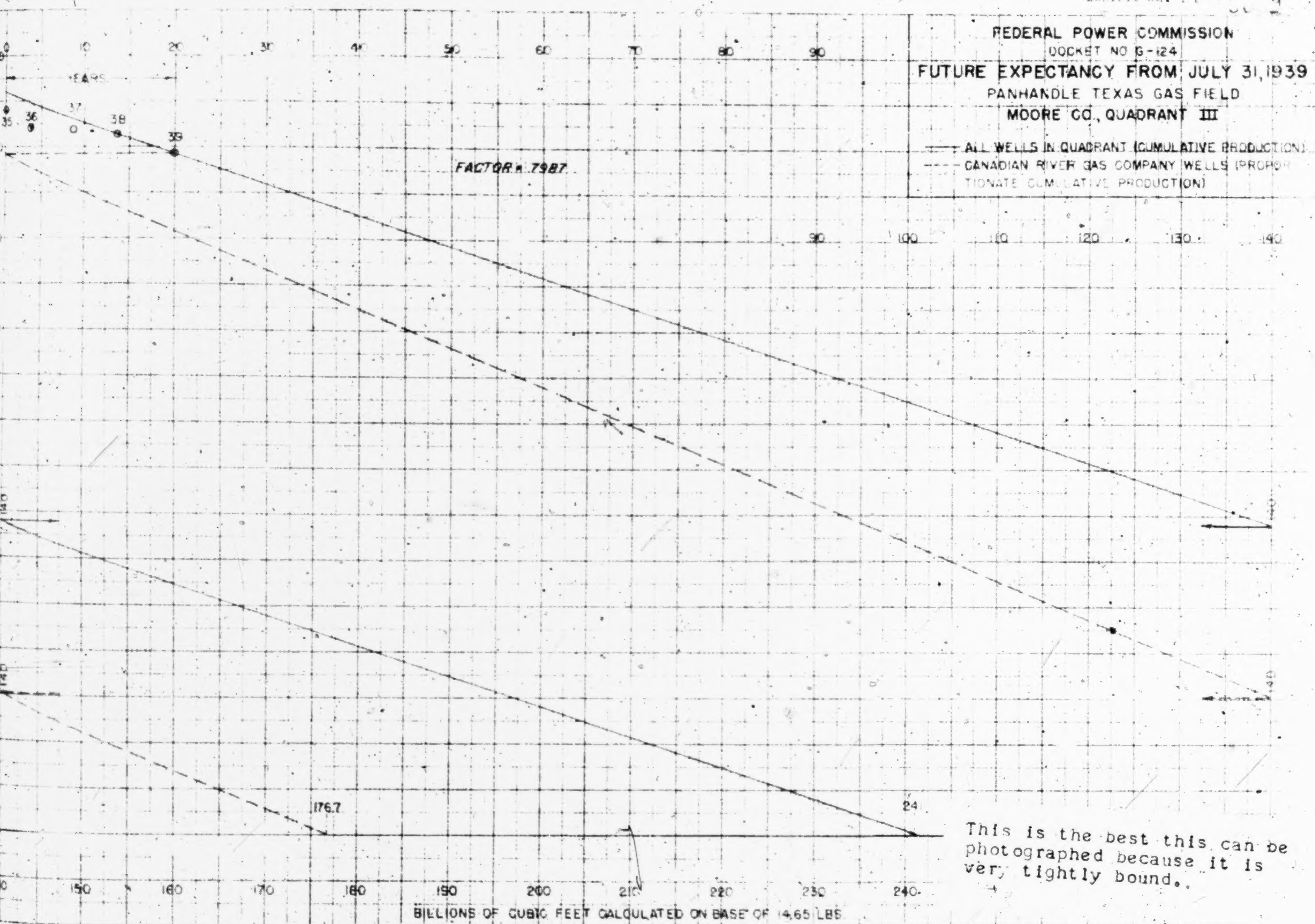

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Exhibit No. 182 150b

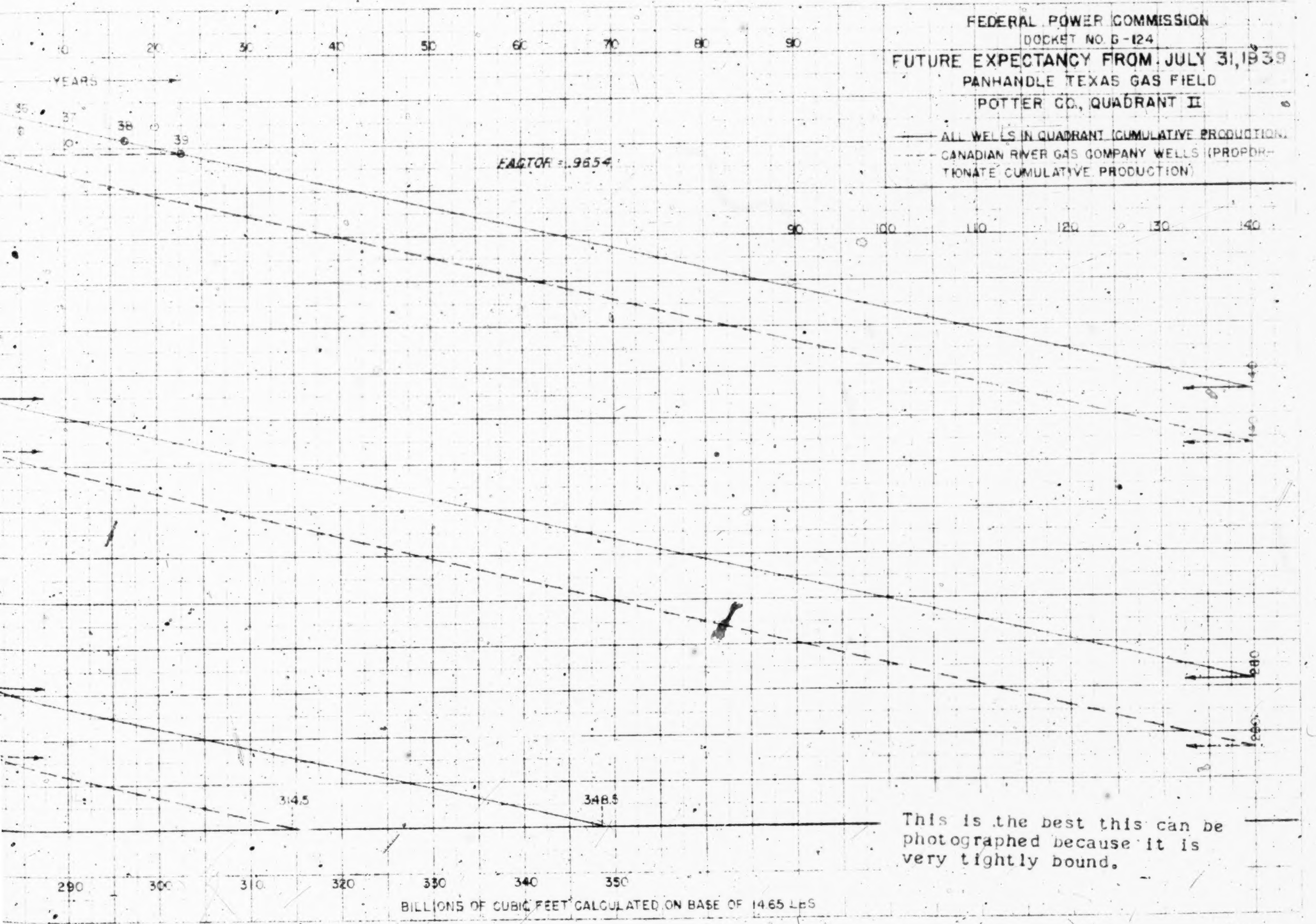

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Exhibit No. 182 1506

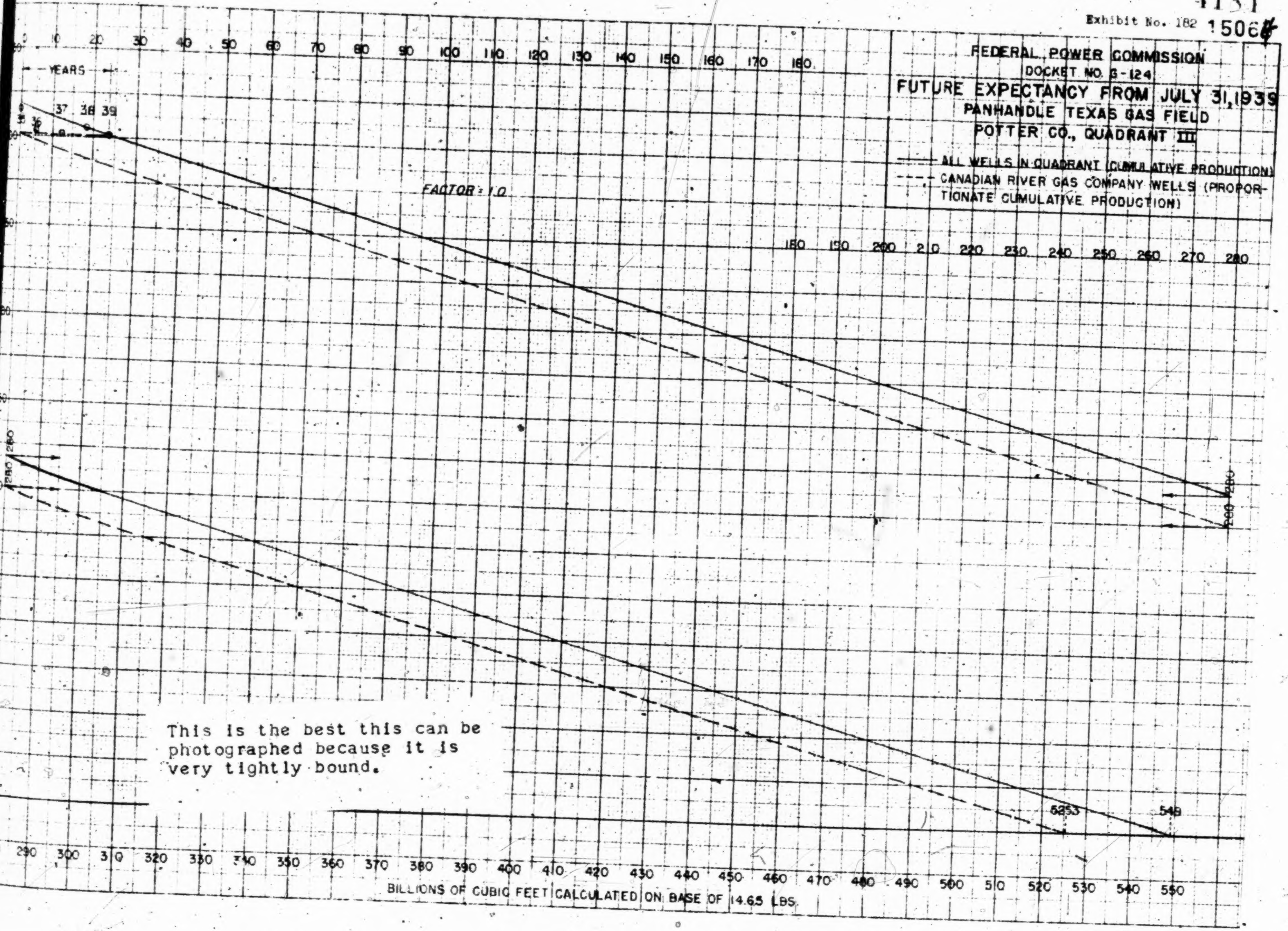

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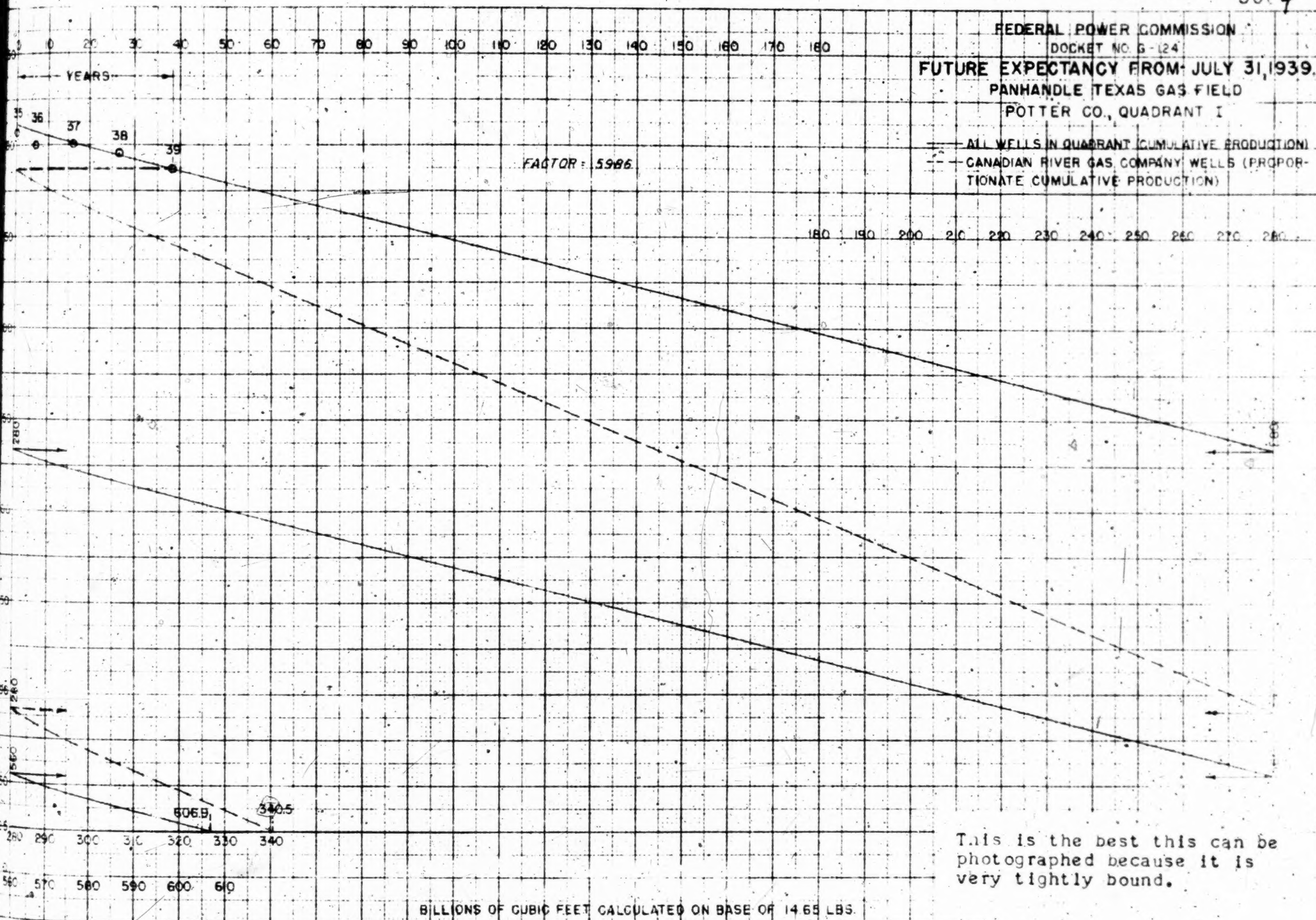
Exhibit No. 18 5004



This is the best this can be photographed because it is very tightly bound.

ESTIMATE OF RECOVERABLE GAS RESERVES
CANADIAN RIVER GAS CO. - PRESENT WELLS - TO 25# WELLHEAD PRESSURE-GAUGE

Figures in Billions of Cubic Feet, calculated on base of 14.65 lb.

County and Quadrant	Year	Production C.R.G. Co.	Production Total Quad.	Production Accumulated Total Quad.	Av. Well Pressures Total Quad.	No. of Wells C.R.G.	No. of Wells Total Quad.	Future Expectancy Total Quad. 7-31-35	Withdrawals Total Quad. 8-1-35/7-31-39	Future Expectancy Total Quad. 7-31-39	Ratio: C.R.G.Co. Prod. to Total Quad. 1939	Future Expectancy C.R.G. Co. Wells 7-31-39
Carson IV	1935				392.2	5	25					
	1936			12.423965	384.9	5	25					
	1937			29.156069	381.1	5	32					
	1938			48.732042	375.1	5	37					
	1939	1.219045	20.546503	69.278545	367.3	5	38	986.0	69.0	917.0	.05933	54.4
Hartley I	1935			-	424.3	3	3					
	1936			.695485	424.2	4	4					
	1937			3.224498	425.3	3	3					
	1938			5.014017	413.0	5	5					
	1939	1.672947	1.672947	6.686964	414.5	4	4	241.5	6.7	234.8	1.000	234.8
Hutchinson III	1935			-	326	13	31					
	1936			12.044676	321	13	33					
	1937			20.970881	316	12	34					
	1938			26.099478	314	13	35					
	1939	.747188	6.402080	32.501558	307	12	35	411.5	32.5	379.0	.1167	44.2
Moore I	1935			-	386	13	26					
	1936			22.420751	377	14	26					
	1937			48.575340	378	14	38					
	1938			75.542559	372	15	45					
	1939	11.329594	31.358345	106.900904	358	16	54	989.0	107.0	882.0	.3613	319.0
Moore II	1935			-	407.4	7	14					
	1936			11,292097	405.9	7	19					
	1937			28.889489	394.7	6	26					
	1938			54.733964	388.1	9	35					
	1939	6.520731	28.461916	83.195880	374.2	9	38	857.0	83.0	774.0	.2291	177.3
Moore III	1935			-	419.6	4	5					
	1936			3.687977	411.1	6	7					
	1937			8.612810	409.6	7	8					
	1938			13.616200	407.0	7	8					
	1939	4.959626	6.209770	19.825970	396.2	8	9	241.0	19.8	221.2	.7987	176.7
Potter I	1935			-	407	7	16					
	1936			6.350014	399	8	17					
	1937			16.118207	400	11	16					
	1938			26.884383	395	12	21					
	1939	6.712379	11.214104	38.098487	387	13	24	606.9	38.1	568.8	.5986	340.5
Potter II	1935			-	412	11	12					
	1936			5.159896	410	12	13					
	1937			10.662206	405	12	13					
	1938			16.471851	404	12	13					
	1939	5.977068	6.191251	22.663102	397	12	13	348.5	22.7	325.8	.9654	314.5
Potter III	1935			-	415	5	5					
	1936			5.107348	403	7	7					
	1937			12.490159	402	8	8					
	1938			18.423562	405	8	8					
	1939	5.251692	5.251692	23.675254	401	9	9	549.0	23.7	525.3	1.000	525.3
TOTAL	1935			-	380.8	68	137					
	1936		79.162106	79.162106	373.7	76	151					
	1937		99.767550	178.929656	376.0	78	178					
	1938		106.588398	285.518056	373.4	86	207					
	1939	44.390268	117.308608	402.826664	357.8	88	228	5,230.4	402.5	4,827.9	.4530	2,186.7

The witness considered the production and pressures of the total quadrants in which Canadian's wells are located (except that he did not consider all of Quadrant 3 Hutchinson County, but only a small portion in the southwest corner of such quadrant). (Vol. LXII, pp. 8789-8791.)

Recoverable reserves were estimated by quadrants. He accumulated the total production by years for each quadrant from mid-year 1935 to mid-year 1939 and from this a curve was plotted and extended to intersect a line drawn through an assumed abandonment pressure of 25 pounds gauge at the wellhead. The recoverable reserves are determined by reading from this curve. The first set of curves contained in Exhibit 182 represents a composite curve for the total quadrants as represented by the solid line, which represents the total expected recovery by all producers owning reserves in the various quadrants. The dashed line represents the estimated recoverable reserves of Canadian only from Canadian wells now drilled.

The witness determined the ratio that Canadian would recover from each of the various quadrants by considering the relation of its production in 1939 to the total production from the quadrants for that year, and assumed that in the future Canadian would continue to capture this proportion of the recoverable reserves of each quadrant. This ratio as determined by the witness averaged throughout all of the quadrants is 45.30%, or stated in another way, .4530 as shown by the twelfth column of the last table of Exhibit 182. The witness stated, however, on cross-examination that if quadrants had not been considered and the over-all ratio determined that this would have given a ratio of approximately 38% rather than the 45.30% utilized by witness. (Vol. LXII, p. 8781.) The calculation, as made by the witness, and which is shown by the dashed line on the composite curve, indicates that Canadian from its present wells will recover 2,186 trillion cubic feet to an abandonment pressure of 25 pounds.

The witness stated on cross-examination that although he had assumed a wellhead abandonment pressure of 25 pounds as the basis for his calculations, that this was predicated upon his belief that it would be physically possible to pro-

duce the wells down to 25 pounds wellhead gauge pressure (Vol. LXIII, p. 8991) but that he did not know much from actual experience about the correct abandonment pressure from a physical standpoint and that he did not know the number of wells that had heretofore been abandoned in the Texas Panhandle Field, or the pressures obtaining at the time of abandonment (Vol. LXIII, pp. 9013, 9014). The actual pressures at which wells will be abandoned will be determined by the economic conditions existing at the time, and he had made no particular study of this phase of the matter (Vol. LXIII, p. 8990) and he had made no assumption of the economic abandonment pressure at this time. (Vol. LXIII, p. 8991.)

Stevens stated that his calculations of reserves, as reflected by Exhibit 182, was simply the application of the pressure-decline method in principle to the estimation of reserves. He plotted the pressures and gave no consideration specifically to the amount of decline for any two successive years. (Vol. LXII, pp 8697, 8698.) He made no study of the geology applicable to the area and neither did he study permeability nor porosity nor sand thickness, but did consider permeability and porosity to the extent that there could be no production if there were not some porosity and some permeability. (Vol. LXII, pp. 8699, 8739-8744.) He did not study drainage. (Vol. LXII, p. 8812.)

He included in his study all of the wells located in all of the quadrants in which Canadian had acreage (except Hutchinson County, Quadrant 3). He did this to incorporate the effect of the production of other companies on Canadian wells—whatever the effect was. (Vol. LXIV, p. 9068.)

The solid line, being the top line on the first set of curves shown in Exhibit 182, represents the total recoverable reserves estimated as recoverable from the present wells in all the quadrants. This curve indicates that all of the wells in all of the quadrants will produce 5.2304 trillion cubic feet of gas to 25 pounds abandonment pressure. The points indicated by 35, 36, 37, 38 and 39, represent the pressures obtaining for the years 1935 to 1939 inclusive. The witness stated that he had his answer before the line was

drawn and he started at the accumulated production total of 5230.4 and drew his line backwards in order to get a straight line. (Vol. LXII, pp. 8868-8869, Vol. LXIII, p. 9059 and Vol. LXIV, p. 9172.) He stated that if his estimate had been made a year earlier and he had not had his 1939 pressure point that the curve would have been almost a horizontal straight line if he had given any weight to the 1935 and 1936 pressure points (Vol. LXII, pp. 8861-8862) and that if he had taken the pressure points for 1938 and 1939 only and had drawn a line from the center of the circle representing 1938 to the center of the circle representing 1939 that he would have had a much more precipitous decline than his curve shows as actually drawn. (Vol. LXII, p. 8863.) He stated, however, that he disregarded the 1935 and 1936 pressure points because waste was existing in the field at that time and he did not believe that these pressures represented a proper build-up. He says that the waste occurred where carbon black and gasoline plants were situated but further stated that he did not know of a single plant of either character located in the area in which he was studying and finally stated that whatever the reason was the pressures for 1935 and 1936 fell below the line as he had drawn it and he had, therefore, ignored them and it would have been just as well if he had not plotted them on his graph paper. (Vol. LXII, pp. 8836, 8846-8854.) He stated again that there was a reason for the 1935 and 1936 pressure points falling below the curve and that the reason, whatever it was, was unimportant. (Vol. LXII, p. 8860.)

The witness was then cross examined as to the curves drawn for each quadrant. He again stated that he had ignored the 1935 and 1936 points. He stated that nature determined the points and that they are good or bad depending upon the proximity of the points to a straight line and if a particular point was above or below a straight line that it should be ignored (Vol. LXII, pp. 8879-8880) and that he selected the points as the basis for his curves which would most nearly represent what the curve ought to be, (Vol. LXII, pp. 8885, 8886) and that the points did not determine his curves but did influence them. (Vol. LXIII, pp. 8895, 8896.) The witness stated that the curves as to

each quadrant were drawn about the way that he thought they ought to be. (Vol. LXIII, p. 8896.)

He stated again that the composite curve was drawn to the predetermined answer, (Vol. LXIV, p. 9172) and without regard particularly to the points and that it could have been drawn so as to more accurately reflect the 1937, 1938 and 1939 points, and if this had been done it would have shown a less reserve than the way it was drawn. (Vol LXIV, p. 9171.)

The witness stated that he had utilized only a portion of Hutchinson County Quadrant 3 because he secured a better looking curve by doing this. He had first drawn his curve for this quadrant and based the same upon the production and pressure data for the entire quadrant but this gave him a slightly ascending curve due to the fact that the quadrant as a whole showed a higher pressure in 1939 than in 1935. (Vol. LXII, pp. 8789-8794.) He stated that Hutchinson County Quadrant 3 was draining gas from Moore County Quadrant 1, and that the pressure of Hutchinson County Quadrant 3 had increased notwithstanding it had produced 172 billion cubic feet of gas over the four-year period studied and had produced more gas than any other quadrant under consideration and it increased in pressure notwithstanding it was also losing gas by migation to the eastward. (Vol. LXII, pp. 8795-8809.)

As heretofore stated the dashed line on both the composite curve and the curve for each quadrant represents the percentage of the total production from the quadrant as a whole and from each individual quadrant that the witness estimates will be produced by Canadian.

The witness stated that the ratio was determined by the summation of quadrants but that it wouldn't have made any difference if he had eliminated the quadrants entirely and had arrived at a ratio by considering the total over-all production of Canadian as related to the total over-all production from all the quadrants. (Vol. LXII, pp. 8776-8779.) This procedure gave a ratio of .4530, or stated another way, a percentage of 45.3%. (See tabulation last page of Exhibit 182.) He was then reminded of the fact that for the year 1939 his Exhibit 182 showed a total produc-

tion for Canadian of slightly in excess of 44 billion and that the total production from all of the quadrants was in excess of 117 million. He stated that this was true and that although he had arrived at a percentage figure of 45.3% based upon the 1939 ratio by means of the summation of the quadrants that he would only have gotten approximately 38% as the ratio or percentage applying to Canadian if he had disregarded quadrants and that this would have given an expected recoverable reserve for Canadian of approximately 1.820 trillion instead of approximately 2.186 trillion, as indicated by the summation of the quadrants. (Vol. LXII, pp. 8779-8782.)

The witness then read figures into the record showing the ratio for the various years of the entire period studied. The production figures, however, were apparently based upon calendar years. This testimony is set out as follows:

ar	Canadian Production	Total Production	Canadian Ratio
36	43.590,010 billion	79 billion plus	50% (Approximately 55%)
37	46.610,252 "	99 " plus	47%
38	42.483,068 "	106 " plus	40%
39	44. " plus	117 " plus	37% plus

The witness then stated that the ratio of Canadian's production to the total production had gone down progressively from more than 50% in 1936 to slightly more than 37% in 1939, and that from the entire area Canadian was producing a smaller and smaller percentage of the total production. The witness ignored the very decided downward accelerated decline in the ratio but stated his ratio of .4530 was based on 1939 production and that it was a weighted ratio. The record does not reflect just what the weighting medium was. (Vol. LXII, pp. 8827-8832.)

The witness stated that although the ratio had been getting smaller and smaller for the past four years, he could not agree that it would likely be still smaller in 1940 and 1941 because the markets might increase (Vol. LXII, p. 8833) but that he had not investigated market outlets of other companies producing in the same area and that the curve representing the ratio was extended into the future without any changes whatsoever and was based upon 1939 performance.

(Vol. LXII, pp. 8834-8835.) He assumed that the present ratio would not change. (Vol. LXIII, p. 8900.) He also stated that although his calculations assumed that Canadian would continue to produce 100% of the gas in Hartley County, he knew that other companies had substantial acreage in that county but that much of the additional acreage was sour gas acreage and he had made no study as to carbon black markets. He assumed there would be no change in the ratio because he did not think it was within the realm of probability that the sour gas acreage would be developed. The Canadian also had a very high ratio, approximately 80% in Moore County Quadrant 3, and although he knew Canadian owns only about one-fourth of the acreage in this quadrant; still he did not consider that the ratio would change. He stated, however, that if the ratio did change in Hartley County and in Moore County Quadrant 3 that his factor of .4530 would change even though Canadian continued to produce the same volume of gas. (Vol. LXIII, pp. 8901-8911.)

The witness stated that as Canadian drilled additional wells it would increase its recoverable reserves and estimated that for three new wells added after mid-year 1939 that Canadian's recoverable reserves had been increased approximately 24 billion cubic feet per well. (Exhibit 182-A.) He stated also that his dashed curve, as shown in his various calculations, would be changed by the drilling of additional wells (Vol. LXIII, p. 8997) but then admitted that the drilling of additional wells would not change the dashed line no matter how many additional wells were drilled unless there was also a corresponding increase in market outlets or production (Vol. LXIII, pp. 9000-9002) and this being true one hundred more wells (or any number more) would not change his calculated reserve figure of 2,186 billion shown in the composite curve, Exhibit 182. (Vol. LXIII, p. 9004.) He also stated that neither any contemplated increase in production nor change in the ratio as represented by the various dashed lines had been taken into account in his study. (Vol. LXIII, p. 9005.) He said, also, that it was possible that conditions in the future might increase the present percentage assigned to Canadian, although he realized that at the present time it had been decreasing from year to

year. (Vol. LXIII, p. 9006.) Witness also stated that he had not changed his solid line being the composite curve as shown in Exhibit 182 by virtue of the drilling of additional wells in the entire area. He stated there were 178 wells in 1937 in the entire area, 207 in 1938 and 228 in 1939, and that although his solid composite curve was based upon 1937, 1938 and 1939 production figures that the line was not changed, or additional reserves indicated by reason of the drilling of the additional wells, and that if the conditions, as reflected by the producing data for those three years do not change in the future that the drilling of additional wells in the future will not increase the reserves (recoverable reserves), (Vol. LXIII, pp. 9006-9009); and finally, that unless additional wells did add additional reserves his estimate of 2.186 trillion recoverable reserves for Canadian would remain as the final figure. (Vol. LXIII, p. 8969.)

He also stated that the total loss in pressure for the year 1939 as shown by Exhibit 182 was 15.6 pounds and on this basis the present wells of Canadian would last approximately twenty years from August, 1939, and that the entire volume of recoverable gas would be produced by the end of that period. (Vol. LXIII, pp. 8970-8971.)

Stevens stated that Hammer's estimate of total reserves in Potter County Quadrant 3 was 448.272 billion, and that notwithstanding this fact he (Stevens) had calculated on his method that the present wells in Potter County Quadrant 3 would actually produce 525.3 billion cubic feet. He stated also that there were now 9 wells in Potter County Quadrant 3 and that the wells were spaced on the basis of one well to almost 4000 acres. (Vol. LXI, pp. 8671-8673.) He stated also that Quadrant 1 Potter County now had 24 wells with a spacing of one well to a little less than 2400 acres, and that everything else being equal the same number of wells in Quadrant 1 Potter County, should produce as much gas as an equivalent number in Quadrant 3 Potter County. (Vol. LXIV, pp. 9114-9118.) He also stated that Hammer's estimate of remaining reserves under Canadian acreage in Quadrant 1 Potter County, was 1,078,766,000 Mcf. while on the basis of Stevens' calculations the Canadian wells in this quadrant would produce only 340,500

billion cubic feet or but little more than one-third of the total remaining reserves owned by Canadian in this quadrant as estimated by Hammer. (Vol. LXIV, pp. 9142-9143.) He stated that drainage into Quadrant 3 was probably the reason that the present wells would produce more than Hammer's estimated reserves and that although he had not considered drainage he was of the opinion that drainage out of Quadrant 1 Potter County did not explain the fact that the present wells in that quadrant would produce less than Hammer's estimate of reserves. (Vol. LXIV, p. 9141.)

The reserve per acre in Potter County Quadrant 1, as estimated by Hammer, is in excess of 22 million per acre, while in Potter County Quadrant 3 the reserve estimate of Hammer is just a little more than 13 million cubic feet per acre. Stevens also stated that the richer the area the greater the production per pound loss in pressure. However, the figures showed this to be just the reverse in so far as these two quadrants are concerned. (Vol. LXIV, p. 9140.) He also stated that the larger the area the greater the production per pound drop in pressure and then stated that the area of Potter County Quadrant 1 was greater than the area of Potter County Quadrant 3 and that the production per pound loss in pressure from Canadian acreage was approximately 1.3 billion per pound in Quadrant 3 while it was but .61 billion per pound in Quadrant 1. (Vol. LXIV, pp. 9126-9134.) He finally stated that he didn't know why a well was producing so much more in Quadrant 3 with a wider spacing and in a less prolific area than it was in Quadrant 1, and he didn't care what the reasons were. (Vol. LXIV, pp. 9137-9138.) He did state, however, that migration of gas out of a quadrant would affect the pressure and the less the migration the less the drop in pressure for any given volume of production. (Vol. LXIV, pp. 9141-9142.)

He again reiterated that there were not enough wells in Quadrant 1 to produce the reserves under the Canadian leases, and that the only basis he had for making this statement was the fact that his calculations showed the present wells would produce only approximately 340 billion cubic feet while Hammer's estimate of reserves showed almost three times this much gas in place and that if the present wells

would produce only two-thirds of the gas remaining at this time down to a pressure of 25 pounds wellhead that this meant he would have to have two-thirds of his 1939 pressure left at that time, and he realized that it would be absurd to expect this. (Vol. LXIV, pp. 9144-9148.) He also stated that when all present wells had been reduced in pressure to 25 pounds at the wellhead that there would likely not be more than 50 pounds pressure left at any point within the quadrant. (Vol. LXIV, pp. 9076-9109.)

The witness stated that the 24 wells in Quadrant 1 were pretty well distributed over the Quadrant. (Vol. LXIV, p. 9114.) The witness did finally state, however, that when all of the wells in Quadrant 1 had reduced in pressure to 25 pounds wellhead there would be very little more gas left in the quadrant above 25 pounds. (Vol. LXIV, p. 9111.)

Stevens further testified (Vol. 62, pp. 8778-8794) as follows:

Q. Mr. Stevens, you stated, I believe, just before the noon hour recess that it wouldn't have made any particular difference whether you had compiled your data quadrant by quadrant or whether you had just forgotten all about quadrant lines and cut straight across.

A. I don't think it would have.

Q. Now, as a matter of fact, isn't it true, Mr. Stevens, that due to the fact that you did consider quadrant by quadrant that you got a higher answer than you would have if you just cut straight across—got a higher answer as to recoverable reserves?

A. I don't think so, if you consider a reasonable drawing or extension.

Q. How is that?

A. I don't think so if you reasonably extended or projected the data of production versus pressure.

Q. Well, you did just that, didn't you, when you took it quadrant by quadrant?

A. Yes.

Q. Yes, all right. Now, you came out as shown by the last page of your exhibit, with a figure 45.3 per cent, didn't you, as applicable to Canadian River?

A. That was the result of the summation of all the quadrants, yes.

Q. How's that?

A. That was the result of the summation of all the quadrants.

Q. That's right, and, now, if you had cut straight through there and had not considered your quadrants at all, you would have come out with a smaller percentage, wouldn't you?

A. What do you refer to specifically?

Q. Well, I'll state it this way, that 45.3 that you show there in total on the bottom of the page, on the last page of your exhibit on the line next to the last on the right—

A. Yes.

Q. You show .453.

A. Yes.

Q. You conclude from that, therefore, that the present wells of the Canadian River will produce 45 per cent of the recoverable reserves under present wells in all of the quadrants, don't you?

A. Yes.

Q. All right. Now, you did that by taking quadrant by quadrant, didn't you?

A. And summating, yes.

Q. That's right. Now, if you had eliminated quadrants entirely and gone straight through with the same data instead of getting a production factor of 45.3 per cent for Canadian River over the whole area, you would have gotten a production factor of approximately 38 per cent, wouldn't you?

A. Yes, considered in terms of the total quadrants as a whole.

Q. Well, now, I am not sure that the question has been answered. Is it correct that you would have gotten 38 per cent of the whole?

A. You tell me how you arrived at that and I think I can answer it a little more clearly.

Q. All right, that's arrived at by taking your rock pressure declines—yes, by taking—take the first column over there on the left. That's 44.390268. What does that represent?

A. That's the total of Canadian River production.

Q. That is the total of Canadian River production.

The next figure is the total production from all the quadrants, isn't it?

A. Yes, that is right.

Q. All right, now, the Canadian River total during the period that you have used is 44 billion plus, isn't it—a little better than 44 and a third billion, is that right?

A. Yes.

Q. And the production for the whole quadrant is 117 billion plus, or a little less than 117 and a third billion, isn't that right?

A. That's right.

Q. Now, what percentage does the Canadian River's production bear to the whole? See if that isn't 38 per cent.

A. That is approximately correct.

Q. All right, then, if you had gone straight through and eliminated your quadrant lines, your factor for Canadian River would have been 38 per cent instead of 45-3/10 per cent you used, wouldn't it?

A. That is approximately correct.

Mr. March: Wait a minute, he wants to make an explanation in regard to his answer.

The Witness: I do not. I wish to shorten that.

Mr. Keffer: All right, maybe if we would just let the witness answer we would get along faster.

Q. Now, applying that to the total there, then you would have come out instead of with 2,186,000,000,000 for Canadian River, you would have come out with 1,820,000,000,000, wouldn't you, as a total recoverable gas under present wells?

A. On the basis of that, that is the case. Is it all right to make an explanation?

Mr. March: Yes. As far as Commission's counsel is concerned, I am sure the Examiner did not intend to rule that you could not make an explanation after you had answered the question to the best of your knowledge and belief.

The Trial Examiner: There is no objection if the witness feels that an explanation is needed, he will not be curtailed

from making such explanation, but the thing I am interested in is to avoid unnecessary explanations.

Mr. Keffer: All right, Mr. Stevens. I might say, that is the position of counsel for respondents, also, Mr. Examiner.

The Trial Examiner: Very well, Mr. Keffer.

The Witness: When I stated this morning that you would get approximately the same answer, that approximately envisaged the difference between that percentage you arrived at of 38 per cent of 45.3. Now, if we consider—while it is not necessary, as stated, to confine ourselves to quadrants, it is nevertheless thought that by breaking up the area into reasonable parts and the reasonable parts were in this case quadrants for the reason of being consistent as much as anything else, we could have taken irregular areas of most any description as long as we were reasonable in taking those areas, but the point of view and the opinion on this splitting up of areas, while the total does give an approximate answer, approximately similar to that using these quadrants, we believe in principle that to split up areas and summate them as is done here is more representative—I shouldn't say representative, it more accurately brings into close association the factors operating in a given area, those given areas being quadrant areas or some other similar areas. We simply take quadrants to be consistent and the quadrants that we take are the same as outlined in previous exhibits, consistency being the essential factor.

Now, we didn't try any other assembly—didn't see any necessity for it. This .4530 that you see down here, due to the varying percentages that Canadian River production bears in these different quadrants to the total quadrant production, that variation is boiled down and incorporated in this .4530 which might be determined a sort of weighted ratio. That is really what it amounts to, and that division of total area into some areas, as we have done here, is believed superior to taking the whole thing at one bite, although the answer by taking it all as a whole is not the same, but I wouldn't call it a serious or great diversion

By Mr. Keffer:

Q. It is about twenty per cent, isn't it?

A. Yes, twenty per cent.

Q. Twenty per cent higher than if you had not considered quadrant by quadrant, that is right, isn't it?

A. That is right.

Q. All right, now, you said we did so and so. Who do you mean by "we"?

A. I mean categorical we, or—

Q. What do you call it—an editorial we? Now, didn't Mr. Hammer work on that, too?

A. Up to the point where the calculation and curves were drawn, several people participated in the collection of data. Beyond that point, outside of casual discussion of the way a curve looked, or something of that sort, why, I completed the work.

Q. Did Mr. Hammer help you on it, then? Is that a correct statement?

A. In the manner described which, beyond this point that I mention, that is, the calculation and assembly and writing of the discussion, after that point it was merely casual as you would look at a curve and dismiss it.

Q. In other words, he helped you up to the point where you drew that straight line which we term a curve, is that right?

A. That is approximately the case. Not only he, but whoever participated in the compilation of the data.

Q. All right, then, you have used the pressure decline method and by taking it quadrant by quadrant you have weighted your pressure decline to a very large degree, is that correct?

A. Well, that composite factor there might be considered a weighting, I think.

Q. A weighting. All right. Now let us go on from that just a step further over to Hutchinson County Quadrant 3. Now, you stated the first thing this morning on the questioning by Mr. March that you deviated from your general plan there and take all of Hutchinson County Quadrant 3 into account, didn't you?

A. Yes.

Q. I understood you to say, Mr. Stevens, that although you didn't take all of Hutchinson County 3 into account, you did take the proportion of Canadian River's; that is, you

arrived at the Canadian River's proportion of the production by taking the production of the whole quadrant into account.

A. No. I might have given that impression and I see how that could happen because right immediately after that I turned the page and saw this compilation of additional wells which has not been in my possession for some time and bringing in those number of wells, perhaps that should be revised more correctly to read this way: That we considered the total production of the new quadrant—call it that if you will—the new designation of area that replaced the designation of area, Quadrant 3 that you see on the map.

A. All right.

A. But that total was considered having in mind the new area adopted.

Q. All right, now, that quadrant isn't outlined anywhere on this map, is it?

A. No, it isn't. It embraces generally that area covered by those wells which were read in the general south and southwest part of the quadrant.

Q. Look at Commission's Exhibit 95; Quadrant 3 of Hutchinson County is outlined there with 3 in it, isn't it?

A. Yes.

Q. All right, now, about what did you take into account in restricting that quadrant as you did for your computation?

A. I will point it out. Perhaps somebody else can point it out better than I can, but—

Q. This colored area is all Canadian River and that is all.

A. Without being exactly definite, I noted on the working papers there that that area was outlined under our '38 map which is not here, of course, but the minute designation of that area, I believe, is relatively unimportant as long as you know the wells that were involved and those were read to you this morning.

Generally speaking, I suppose, it comes down about—

Mr. March; Describe it.

The Witness: It is difficult to describe on this map, but it includes the southwestern part of Quadrant 3 as outlined

on Exhibit 95, embracing those areas shown in color and owned by the Canadian River Gas Company.

Mr. Lange: Quadrant 3 of what county?

The Witness: Hutchinson County.

By Mr. Keffer:

Q. Well, now, you used 35 wells out of Quadrant 3 in Hutchinson County. How many wells are in that quadrant, Mr. Stevens?

A. I did not look that up. I believe you wanted that—

Q. I believe I did. I believe I asked you that this morning.

A. It is a question of counting them.

Q. Sir?

A. It is a question of counting them. I can do it now if you want me to.

Q. Would it take very long? If not, you can do it during recess. Do you have it listed there?

A. By the way, the other reporter has it.

Q. We won't take the time to count them now, but there is a lot more than 35 wells, isn't there?

A. Yes.

Q. All right, now, in restricting, or taking just a limited portion of Quadrant 3, Hutchinson County, you got a lot bigger factor for Canadian River than you would have gotten for Canadian River had you considered it all, as you did on the other quadrants, didn't you?

A. Yes, but you had a lesser total amount of gas to multiply that factor by.

Q. Yes, I know, but as a matter of fact, as you have computed in here, you show Canadian River somewhere around eleven per cent of the gas produced from the quadrant as you limited it or restricted it?

A. Yes, sir.

Q. Whereas, if you had not restricted it, Canadian River would have had something like one per cent or maybe a little better?

A. One per cent of a great deal larger number, yes.

Q. Yes. Do you have any idea which is the greater figure—11 per cent of the smaller number or one per cent of the larger number?

A. No, I don't, and that is unimportant for the reason that the area considered gave a good curve, one that could be logically drawn through points and whatever grouping was determined, whether this identical one is described or some sligtly smaller or larger, if you had obtained a good curve through those points your answer would be equally valid.

Q. All right, now, you stated in answer to Mr. March's question this morning that you cut out the southwestern corner of that for the reason that that is a pretty long quadrant and all of Canadian River's wells were down in the southwestern corner, isn't that the reason you gave?

A. Well, that is probably the principal reason that I would recall at the present time.

Q. Now, didn't you have a much better reason than that, Mr. Stevens, that you didn't give?

A. As I remember, we tried the total quadrant and it didn't result in nearly as good a curve and I believe that that was one of the reasons also suggested for restricting it. It became evident that restricting it to a smaller part of the quadrant might give a better curve for projection and we found that it did as a matter of fact, and used that, which is entirely—

Q. Now, as a matter of fact, isn't the only reason you have for restricting it and not including the whole, is the fact that this method of yours wouldn't work on it at all if you included the whole?

A. You overlooked, I think—

Q. Just answer my question yes or no.

A. Read that.

(The question referred to was read by the reporter, as set forth above.)

The Witness: The fact is that it worked far more satisfactorily with the collection of data on that basis and that in itself is sufficiently good reason.

By Mr. Keffer:

Q. I see; you were looking for an answer, is that your answer?

A. We were looking for a proper lineup of points considering sufficient area and that is justified in any of this

kind of work and there is a further point which should be mentioned in explanation of this, that—to quote your previous illustration, if the Canadian River Gas Company's production represented a very very small percentage of the whole, say one per cent or less, it is obviously an advantage to reduce the area to a size where Canadian River occupied or produced a relatively larger per cent of the whole. That is not necessarily a weakness in method. It is simply a better presentation of facts because, after all, we haven't anything else in here but facts and that rearrangement to a smaller area, as I say, and as I recall from the figures, gave a better curve and hence an equally valid answer.

Q. What kind of a curve did you get when you first plotted it on the whole quadrant, Mr. Stevens?

A. I don't remember that. It could be easily found out. The data is in the working papers there.

Q. Didn't you have a gradually ascending curve instead of a descending curve?

A. It might well have been, I don't recall.

Q. What would give you an ascending curve on that?

A. An ascending curve would be caused by a—well, simply by a lack of decline in pressure against accumulated production.

Q. That's right. What would cause a lack of decline in pressure?

A. A lack of decline in pressure as it would appear on the paper would result from production in a very permeable area, perhaps, which would—and draining a large area through widespread wells, which would serve to give a lower —would serve to give a larger area—a larger production per pound. That would serve to flatten or even incline the production pressure curve.

Q. Well, now, you have given two things; one is a highly permeable area and the other I believe you stated was a small decline per pound production for that reason. Really, after all, it gets back to one reason, doesn't it—a highly permeable area?

A. Possibly that, with the assumption that the wells are fairly widespread or widely spaced.

Q. Oh, yes, I believe you did bring in the wide spacing of wells. Do you know how the wells are spaced in that area?

A. I haven't looked—I haven't considered that. This area was simply for the purpose of getting a better curve and outside of that we did not investigate details of that kind.

Q. Now, as a matter of fact, Mr. Stevens, isn't it true that you have more wells per acre in Quadrant 3, Hutchinson County, than any other single quadrant that you considered?

A. I don't know about that.

Q. Well, don't you care to hazard a guess about it?

A. No.

Q. All right.

A. If it is true, why, that is—

Q. All right. Now, do you have your work sheets there?

A. The reporter has them.

Q. Now look over that quadrant and see what we find there.

Mr. Lange: Here they are.

(The documents referred to were passed to the witness.)

The Trial Examiner: With respect to wells now, Mr. Keffer?

Mr. Keffer: No, with respect to pressures.

Q. I believe your work sheets, you said, didn't show the wells. I believe it does, too.

A. Yes, I show wells.

Q. Well, go on to pressures. That's what I had in mind. He is going to check the wells during recess, Mr. Examiner. That is all right with me.

You have the pressures shown there?

A. Yes.

Q. All right, in 1935 the quadrant pressure was 247 pounds, wasn't it, the total quadrant?

A. I don't think that—what did you say that was?

Q. 247 pounds, the total quadrant.

A. Well, now—

Mr. Lange: Speaking of the—

The Witness: The quadrant as I have it here—

By Mr. Keffer:

Q. I know, but I am talking about the quadrant before you changed it.

Mr. Lange: Referring to well head pressure, Mr. Keffer?

Mr. Keffer: Yes, that is all the well head pressure.

The Witness: ~~247, yes, is shown here.~~

By Mr. Keffer:

Q. All right, the pressure in 1936 was 253, wasn't it?
A. 246, I have it here.
Q. 246 in 1936. All right, what was it in 1937?
A. 253.
Q. What was it in 1938?
A. 253.
Q. 253—what was it in 1939?
A. 250.
Q. All right. You had a bigger pressure in 1939 than you had four years earlier in 1935, didn't you, a higher pressure?
A. Yes.

* * * * *

Stevens further testified on redirect examination (Vol. 63, pp. 9041-9063) as follows:

Q. Mr. Stevens, which one of these methods do you prefer for depleting the wells over the life of the wells or the life of the leases?

Mr. Spencer: Mr. Examiner, let us have him qualify the witness first. When I left him he wasn't qualified.

Mr. March: I asked him which one he *prefered* and that is all that is necessary for him to answer, if he has an opinion.

The Trial Examiner: I believe he just stated in response to cross examination, Mr. March, that he had made no study of the property depreciation and depletion other than that this system he proposes would be the logical method to use.

Mr. March: I want to know why he thinks it is the logical method.

The Trial Examiner: Is that what you want to know?

Mr. March: Yes.

The Trial Examiner: All right.

By Mr. March:

Q. Which one of the methods do you prefer and why?

A. Personally, I prefer this one described here as far as preference has any significance. Of course, it seemed that it was the logical one because it was tied in intimately with the life of the well or the use of the well—is tied in logically with the period of use and that is really the fundamental and probably the only basis of preference that the depletion is tied in with, the amount of gas that is going to be depleted. That seemed the very logical thing to me and that is probably the only and main reason for the preference.

Q. Your position is that you are depleting wells and that you should have the depletion period over the life of the wells?

A. Which is the history of the recoverable reserves, which is the period of producing from the recoverable reserves of the period in question. That is stating the same thing I believe.

Q. In other words, the leases aren't going to last longer than the wells?

Mr. Spencer: Mr. March, quit testifying. There is nothing in the record to substantiate that.

The Trial Examiner: Mr. March, I think you can reframe your question. I think that question you asked is wholly improper.

Mr. March: All right, sir.

Q. In your exhibit here, Mr. Stevens, do you state in effect that you can recover all of the gas from present wells under these leases?

A. If I understood your question correctly, the title of the exhibit describes it, it being "The estimate of recoverable gas reserves, present wells," and that reserve not being synonymous with total reserves to be recovered under leases, the difference between the two being recoverable by additional wells.

In short, to recover the reserve under leases, it will be necessary to drill more wells.

Q. Are you through?

A. Yes.

Q. In your opinion can you get all of the gas out from under these leases by the present wells?

A. Not on the basis of the production record to date and not on the basis of this study, which is the production versus pressure records.

Q. Are you attempting here in any way in this exhibit to give an estimate of reserves under leases?

A. No.

Q. Would it be true to state—strike that.

If your were calculating the reserves under the acreage of Canadian River or the reserves in the quadrants in which Canadian River acreage is contained, would you do it by this method?

A. What—

Q. By this method, I mean the method employed to calculate the reserves which these present wells can get out of the ground.

A. You mean if I were calculating the reserves under leases?

Q. That is right.

A. No, I wouldn't use this method.

Q. Why not?

A. Well, for the reason that the effect of weighting pressure against acreage establishes a basis upon which reserves under leases can better be calculated than does this method. While they are in general principle an expression of the utilization of the pressure decline method, yet the method used under that principle differs from that used by Mr. Hammer in the calculation of reserves under leases.

Q. If you wanted to get all of the gas from under these leases, would you have to drill more wells?

A. On the basis of this study, yes. Putting aside the purely theoretical consideration in indefinite time a given well will drain more than in any finite time, naturally, and the conditions of production are different as indicated by the production record constitutng the method here, and it will be necessary to drill some more wells to recover all of the Canadian River gas.

Q. Do you believe—strike that.

Would you be willing to testify for the record here that the Canadian River Gas Company has only two billion, two

hundred fifty-eight million, seven hundred eighty-nine billions—wait a minute. Is that two billion?—it is two trillion, isn't it—pardon me.

A. It depends upon whether you are going to call it Mcf. or not.

Q. 2,258.789 billions.

A. What are you referring to, Mr. March?

Q. I am referring to Page 3 of your Exhibit 182, where you give there the total recoverable reserve, December 31, 1939, including production for August 1, 1939 to December 31, 1939 from the present wells.

A. You are referring to the figure 2,238.849 billions?

Q. That's right.

A. Yes. In fact, I have so testified.

Q. You testified that that is all the reserves Canadian River has?

A. I'm afraid I did, and I'm sorry.

Q. I will ask you the question again. In your opinion, does the Canadian River Gas Company just have reserves under its leases amounting to over two trillion as you have the figure here recorded on Page 3?

A. That is not the reserve under leases. They have more than that under leases. This is the figure on reserves under wells, and the reserves under leases has been given in a previous exhibit.

Q. Is it your intention, either impliedly or otherwise, to give here an estimate of the remaining reserves under Canadian River leases?

A. No, it is not.

Q. And as I understand you, if you were computing the reserves under leases you would have employed a method employed by Mr. Hammer?

A. Yes.

Q. And you would not employ the method employed here?

A. That is right.

Q. As I understand your exhibit here, 182, it is an exhibit which involves the study of the action of wells and wells alone?

A. As expressed in your production and pressures, yes.

Q. It has nothing whatsoever to do with acreage?

A. That is right.

Q. We have had considerable discussion here as to why

you employed quadrants, why you used the same quadrants that Mr. Hammer used in his exhibit. The question was asked you as to what your estimate of reserves which could be recovered by the present wells would be if you had disregarded the quadrants, and I believe there was some statement made here that it was twenty per cent—it would be twenty per cent lower. Now, have you made a calculation to determine exactly what per cent lower it would be?

A. That would be 16.455 per cent below the figures shown for 7-31-39. That was the basis upon which the computation was based, of course.

Q. And why didn't you ignore the quadrants?

A. For the general reason that it was desirable to split up the area in some manner. It could probably have been done in some other form of areal distribution than the quadrants shown. The only reason for taking the quadrants as shown was more one of consistency than anything else, but that they should be broken up into some areas—quadrants in this case is preferable for the reason that analysis of the characteristics of component parts can be more closely studied and the diverse effects in those areas be more accurately charted and weighted into a whole to arrive at, by summation, a result which result is I believe superior to a similar result arrived at by a wholesale consideration of the total area involved.

Q. Is it correct to state that probably the principal reason was that you thought it necessary to have wells in adjacent territory grouped together and studied separately and then relate them to the whole?

A. To relate them to the whole by summation, yes.

Q. Now, I believe it was brought out that you followed exactly the quadrants as contained in Mr. Hammer's exhibit with the exception of Hutchinson 3?

A. Yes.

Q. And I believe it was likewise brought out that the only reason that you did that is because there were no Canadian River wells in the northern part of that quadrant at all?

Mr. Keffer: Now, if the Examiner please, that is not the record, Mr. March. That is not what the record shows. That is what you said.

Mr. March: I will ask him that a different way if Mr. Keffer insists.

Q. Will you explain for the record just exactly why you did not use all of Hutchinson County, Quadrant 3, as Mr. Hammer had delineated it on his map?

A. We started to use it that way consistent with all the others. The nature of the pressures of the wells of other companies in the north—general northern part of the quadrant is such that when projected against accumulated production it gave a very erratic curve, in fact, it was almost an ascending curve if not actually so.

Mr. Keffer: Almost what kind?

The Witness: Ascending. That suggested, looking at the quadrant with respect to distribution of Canadian River acreage and noting that it was entirely in the southwest corner—the suggestion was apparent that perhaps a treatment of that part of the quadrant directly related and adjacent to Canadian River acreage might result in a better alignment of data and constitute a better basis for estimation of Canadian River's recoverable reserves. That proved to be the case and it was simply adopted for those reasons.

By Mr. March:

Q. Mr. Stevens, are there any Canadian River wells at all in the northern part of Hutchinson Quadrant 3?

A. Not that I recall. I am quite sure that is the case. If there had been it would have—well, Exhibit 95 will show that very plainly I think. Here is Canadian River acreage over here (indicating).

Q. Are there any Canadian River wells in the northern part of Hutchinson 3?

A. According to this exhibit there are not, nor do our records indicate any.

Q. According to this exhibit, where do you find the Canadian River acreage?

A. In the southwest part of the quadrant.

Q. Solely in the southwest part of the quadrant?

A. Yes.

Q. Now, Mr. Stevens, if there had been Canadian River wells up here in the northern part of the quadrant, you could not have disregarded the northern part of the quadrant, could you?

A. No, you could not have.

Q. Oh, yes, there was some further discussion about

that, so therefore the principal reason was you did not use the northern part and did not deem it necessary because no Canadian River wells were up there, is that not correct?

Mr. Spencer: Now, there he goes again—"the principal reason." Let the witness state what the principal reason was.

The Witness: Those are the principal reasons and those are valid reasons I think.

By Mr. March:

Q. Oh, yes, there was some discussion—I believe you admitted that had you used all of Hutchinson 3 in spite of the fact that there were no Canadian River wells in the northern part of it that you would have got a gradually ascending curve?

A. As I recall it was of that nature almost. It certainly wasn't a definitely descending curve in the sense that these others are.

Q. Mr. Stevens, in any of these other quadrants using the data for 1937, 1938 and 1939, do you have a similar situation?

A. Not with respect to the values for those three years, no.

Q. You don't have any quadrant—do you have any quadrant at all which was comparable to Hutchinson Quadrant 3?

A. No, there were none.

Q. Now, Mr. Stevens, there has been a great deal of discussion about these curves that you have drawn here as reflected in Exhibit 182. Now, I want to direct your attention to the individual quadrant curves which you have constructed. There was some implication that in these individual curves that you arrived at your answer first and then drew your line. Is that correct?

A. There might have been. I believe there was, partially, at least.

Q. Now, I direct your attention to Quadrant 4, Carson County, which is the first quadrant curve. Now, I will ask you, did you determine mathematically the points there before you drew your curve?

A. In the sense of arithmetic, yes, and that the pressures were averaged and the production was accumulated.

Q. You plotted to arrive at those individual points there your production against your pressures?

A. That is right.

Q. And it was after that that you drew your line?

A. That is right.

Q. Your curve?

A. Yes.

Q. Now, I direct your attention to that curve and ask you whether or not it would be possible for you to draw that curve any other way without increasing your estimate, giving consideration to '37, '38 and '39.

A. It would not have been possible to draw it any other way without increasing the estimate of reserves, for the reason that had we drawn it any other way to more completely employ '37 than we have, the result would have been a curve at a gentler slope which would have the effect of increasing the reserves.

Q. Then it would have been impossible for you to draw this line any other way, giving proper consideration to '38, '37 and '39 without increasing your estimate?

A. That is true.

Q. Now, Mr. Stevens, I want you to go through—glance through every single one of these quadrants here—Quadrant curves, and tell me which, if any, you could have drawn differently, giving consideration to '37, '38 and '39, without increasing your estimate of reserves.

A. The next one is Hartley County Quadrant 1. If any more consideration had been given to 1938, it would of course have increased the estimate of reserves for that quadrant. However, if we accept the premise that '38 is obviously low for some reason, then '37 should be given more weight and '38 ignored. The result in this case would have been a very slight decrease of the estimate of reserves.

However, that lineup of points there is probably, and in general, considering average opinion, I believe the only one where any logical change would decrease rather than increase the estimate of reserves.

Q. You just check the others to play safe.

A. And the next one, Hutchinson 3, described as being in the southwest part of the area, Hutchinson 3 marked on Exhibit 95, we have a lineup of points there in which 1936 does not appear to be had. However, it wasn't given major weight, but if 1938 were given any more weight than is

given there the result would have been an elevation in the reserves and an increase in the estimate of reserves.

Mr. Keffer: How about 1939, if you had drawn it right through the center of it?

Mr. March: I am asking the question, Mr. Keffer.

The Witness: That would ignore 1938, Mr. Keffer.

Mr. Keffer: How's that?

The Witness: That would ignore 1938. We are considering all three points.

Mr. March: I am asking the questions, Mr. Keffer.

Mr. Keffer: Take 1938 like it is, drawing the line through 1939.

By Mr. March:

Q. Could you have drawn this line giving *consideration to* '37, '38 and '39 any differently from what you have done without increasing your estimate of reserves?

A. No, it couldn't be done without increasing the estimate of reserves unless—

Q. That's all now. Just a moment—

Mr. Spencer: Mr. Examiner, can't the witness finish his answer? Must I protect him?

By Mr. March:

Q. Now, Mr. Stevens, could you have drawn that line any other way, any lower, giving a lower estimate of reserves and still touch '38?

A. No, you could not. That was the point I was about to mention.

Q. Now we'll go to the next one and check that one.

A. Moore County Quadrant 1.

Q. Right.

A. That, as I see it, is the only way that could be drawn without ignoring 1937, and the only way it could be drawn to show a lesser reserve would be to ignore '37.

Q. I will ask you this question: Could that line have been drawn any other way, touching all three of those, touching '37, '38 and '39 without increasing your estimate?

A. No, under those conditions it could not have.

Q. All right. I will ask you the same question with regard to Quadrant 2, Moore County.

A. That is right, also with respect to Moore County, Quadrant 2.

Q. In that case, Mr. Stevens, if you had gotten closer to the point of '37 than you did, would that have increased your estimate of reserves?

A. That is right, it would have.

Q. The next one, Moore County, Quadrant 3. Now, Mr. Stevens, in that case you split 1938 and 1939 points right down the middle. Now, if you had gotten any closer to the 1937 point, would that have increased your estimate of reserves?

A. It would have.

Q. Potter County, Quadrant 1, could you have drawn that line, touching each of the three points 1937, '38 and '39 without increasing your estimate of reserves?

Mr. Keffer: Now, just there, Mr. Examiner. Mr. March made that statement many times and made it again here. I have let it go, but it is so erroneous it distorts the record and I feel that some observation and objection should be made at this time.

He talks about "touching the point '38," which the line does not do at all, which he can tell by looking at it.

Mr. March: If you would like my language a little better and a little more concise and complete, I will state it this way:

Q. Mr. Stevens, could you have drawn this line any closer to the 1938 point without increasing your estimate of reserves?

A. Well, you could draw it through the center of '38 and '39 and it would decrease the amount of reserves.

Q. I am talking about the three years.

A. But giving equal weight in the situation to '37, you could not do that.

Q. But now since you brought that up, Mr. Stevens, I want to ask you this question: Would you have attempted anything like this if you just had the data for the two-year period, '38 and '39, and had no other data?

A. In general one would not draw a curve on two yearly

points unless he had to. In a couple cases here we have split '38 and '39 points, but even so, '37 has played some reasonable relation, but in the event of having all of these nine quadrants based on only two points, it is quite unlikely that the reserves would have been drawn in this manner and using this same group of data.

Q. Your statement is, as I understand it, that if you had just had the data for a two-year period, '38 and '39, you probably would have never made this study in the first place because it would be inadequate for such a study like this.

A. That is true, yes.

Q. And in every case you drew a line here, you did give some consideration at least to the three-year period?

A. Yes, even though, as stated, the curve was drawn through '38 and '39, that represents about two cases, I believe.

Q. All right, let's go to the next one, Potter County, Quadrant 2. Now, I will ask you—there is a quadrant in which you split the points of '38 and '39 and you missed 1937. Now, I will ask you this: If you had given any more consideration to 1937 than you did give, what would have been the effect on increasing or decreasing your estimate of reserves?

A. It would have increased the estimate.

Mr. Spencer: There is a place, Mr. March, where you used two points.

Mr. March: The witness has testified he always gave some consideration to the three points, although in this particular case here it pierces right through the center of '38 and '39.

Mr. Spencer: Right.

Mr. March: The witness also testified that he wouldn't even have prepared this exhibit if he just had data for two years.

Q. Now, the next one, Potter County, Quadrant 3. Now, there is a case again where you ply right through the middle of '38 and '39, and you miss your 1937, it is below the line. Now, I will ask you this question: If you had given

any more consideration to 1937, what would have been the effect thereof?

A. It would have increased the estimate for that quadrant.

Q. Now we turn to our composite, Mr. Stevens. On your composite, how did you arrive at your 1935 point?

A. '35?

Q. How did you arrive at your '35 point?

A. The '35 point at zero production is simply the average production for 1935.

Q. Is the 1935 point the composite of all the 1935 points upon your individual quadrants?

A. Yes, in that it is a summation of all the wells in all the quadrants.

Q. Now, how did you arrive at your 1936 point?

A. The summation of all well pressures in 1936 reduced to an average, plotted against the total quadrants—production for 1936.

Q. It is your—is your 1936 the composite of all your points in the preceding quadrants?

A. Yes.

Q. How did you arrive at your 1937 point?

A. In the same manner.

Q. And your 1938 point?

A. The same manner.

Q. And your 1939 point?

A. In the same manner.

Q. Now, Mr. Stevens, I will ask you this question: Would it have been possible to have drawn this line on your composite any differently from the way you did draw it, coming any closer to all three of your points, your '37 point, your '38 point and your '39 point?

A. In general that occurs to me to be a very sensible interpretation of those points. Now, it must be remembered in the case of this total curve or composite curve that the summation of data did give us another point which is the end point at 25 pounds abandonment; so in a sense perhaps this curve should be described as being drawn not only on three points *prinarily*, but on four points since you know in that case the answer that you had to come out to.

It would have been possible to draw it backwards, as a matter of fact.

Q. Let's forget all about the answer which you had now, the answer which you had over here on the right-hand side of your page, the fourth point that you had, and I will ask you this question again: Would it have been—do you understand the question?

A. Yes, I do. As it is the line, as far as I can determine it here by eye, splits '38 and '39 equidistant—split the space equidistant between those—

Mr. Keffer: '38 and '39 equidistant?

The Witness: They are very very close to it.

Mr. March: Get your slide rule on that. Have you got your slide rule on that—I mean your triangle?

Mr. Keffer: He has that to check that distance as between '38 and '39—

Mr. March: You can cross examine the witness when we get through, Mr. Keffer.

Mr. Keffer: Well, that will be some time, and I don't want an obviously false statement to go in the record.

The Witness: Regardless of whether you consider it a serious error in judgment, it represents a very reasonably drawn line and with regard to the statement that four or five engineers would have all drawn a different line, it is, of course, possible for fifty different engineers to draw fifty different lines as may be dictated by considerations which may be from prejudice or diverse judgment, whichever applies, but there is very very few different ways in which this line could be possibly drawn and drawn sensibly.

Mr. March: Yes.

Q. Then is your statement here—is my statement correct, after you observe this, could this line have been drawn any differently, giving more consideration than you have given to the points '37, '38 and '39—giving consideration to all three points?

A. To give more consideration to '38 and '39 would have given a less reserve, but it would have resulted in giving less and less weight than '37 appears to deserve.

Q. Yes, but if you had—

A. So assuming that with respect to '37 which has not

been ignored in previous cases—there is no reason why it should be ignored here, and I simply regard it as a very reasonably drawn line.

Mr. Spencer: Mr. Examiner, perhaps I misinterpreted the witness' testimony. It sounds to me as if he were saying that he had exercised some judgment in drawing the line. As I recall his testimony on cross examination he had a point which he had to reach, the course of the line backwards was determined before he started—

The Witness: It was determined in a sense, yes.

Mr. March: He can explain that.

Mr. Spencer: I just didn't want the impression here—

Mr. March: Go ahead, Mr. Stevens.

Mr. Spencer: If the record is clear, that is fine.

The Trial Examiner: I think he did, Mr. Spencer.

Mr. Spencer: Pardon me for interrupting.

The Trial Examiner: As a matter of fact, I think he reiterated his statement on cross examination.

By Mr. March:

Q. Now, Mr. Stevens, I want to ask you this question: If you had given—what would have been the effect of the situation if you had given any more consideration to 1937 than you did?

A. Well, you would be getting farther away from 1938. You could do that in two ways. You could move the line in a general southward direction parallel to itself perhaps, or you could have swung it about the point it now occupies near 1939.

Q. Well, if you had moved 1937, the line any closer to 1937—do you see what I mean?

A. Yes, it would have gone farther from 1938 and given less weight to 1938.

Q. Well, what would have been the effect of that? would it have increased or decreased the estimate?

A. It would have increased the estimate.

Q. Can you tell me how you could have drawn that line any differently from what you did, giving consideration to

all three points, without increasing your estimate—in fact, all three points?

A. Yes, I understand. I don't see how it could be changed without any justification whatever, having in mind the effect of 1937; that is, assuming that we did not know what the total was and were drawing this entirely with respect to the points. However, this curve is simply a summation of the data. It represents the summation of the data from which the other curves were drawn individually.

Q. As I understand it, before you started drawing this curve you had something that you didn't have when you started drawing these other quadrant curves?

A. That is correct.

Q. You had the answer, is that correct?

A. That is right.

Q. You had the slope of the curve?

A. Yes.

Q. But if you had not had that answer, if you had not had that slope,—I mean indicated, and you had just had these points up here; then is there any possible way in which you could have drawn that line, other than what you did, giving consideration to '37, '38 and '39, without increasing your estimate?

A. No reasonable way that it could be done without doing so.

The witness further testified on recross examination (Vol. 64, pp. 9104-9176) as follows:

Q. Now, you have agreed with me, I take it, then, that if the present wells in Quadrant 1, Potter County, will produce all the gas in that quadrant, then the drilling of additional wells certainly would not increase recoverable reserves except to a very very minor extent possibly. That is correct, based upon the assumption.

A. You aren't asking me to affirm the assumption, are you?

Q. No, not the assumption, the result based upon that assumption, that's all.

A. Well, the result based on that assumption is, as you say, but I would like to add that it is an erroneous assumption, that's all.

Q. Well, it may be. I am not admitting that it is er-

roneous, mind you. Now, will you tell me what part of Quadrant 1, Potter County, that the present wells will not drain—will not produce all the gas now underlying that quadrant? That's my next question.

A. That question—

Q. Just answer my question.

A. It will be as stated before, I believe, that the amount of gas it won't drain would be in the area least accessible or available through action of permeability to the wells.

Q. All right, point it out on the map. I want to know where those areas are.

A. It would be in the areas of highest pressure, without even looking at the map, as compared with the lower pressures wherever they are located.

Q. All right, you are going to assume at the end of that period, whenever you are down to 25 pounds, that the southernmost wells of that area which are now in the highest portion of the area, when they are down to 25 pounds, certainly everything north of them is going to be down to 25 pounds.

A. The central point—

Q. Just answer that question. Isn't that a fact?

A. That the area north of it—

Q. Yes, is going to be down to 25 pounds, too, because it is already much lower, or some lower than those southernmost wells.

A. That is a reasonable assumption, but there is still the fact that some other areas will be over 25, and whatever they are—

Q. What other areas?

A. Whatever they are is unimportant. It is the fact that they will be there and their specific location is really extraneous to this except in principle.

Q. You say they will be there. That's the very thing I want to find out. How do you know they will be there? Give me your reasons.

A. You have agreed on many occasions that areas away from the well will be at higher pressure.

Q. That's right, but how much higher?

A. I stated that that is indeterminate.

Q. You know it wouldn't be very much, don't you?

A. You do not even know that, but as to the degree, that has been stated to be indeterminate.

Q Would it be as much as 10 per cent of the total?

A. It is indeterminate.

Q. How's that.

A. You were talking about pressure a minute ago.

Q. That pressure is still what we are talking about. You say the pressures would be higher away from the well, didn't you?

A. Yes.

Q. And I have agreed with you that that is a fact.

A. Yes, and I simply decline to hazard a guess as to how much it would be.

Q. I just asked you if it would be as much as 10 per cent.

A. If you can't say in pounds, you can't say in per cent.

Q. Do you have any idea how much?

A. No, no one does.

Q. Would you say 10 per cent would be too high or too (illegible).

A. I don't say anything about it.

Q. You just don't know?

A. I just don't care to hazard a guess. It is just impossible.

Q. All right, let's get back and we'll leave this for a moment. Now, you follow me here. You said a while ago your gas would remain in areas of higher pressure when you get down to 25 pounds.

A. That is a general statement of fact.

Q. It is a correct statement, isn't it?

A. Yes.

Q. Now, the southernmost wells in that quadrant now are some 2½ miles from the south boundary line of the quadrant, are they not?

A. The wells.

Q. Yes.

A. Yes.

Q. All right, now, those wells are in the highest producing area of the quadrant where wells are located aren't they; that is, those wells have higher pressures than other wells in the quadrant?

A. Well, as a matter of pressure, yes. You are tying in production with—

Q. No, I am talking about pressure.

A. All right.

Q. The pressures of these southernmost wells are the highest pressured wells in the quadrant.

A. Yes, sir.

Q. Now, when those wells are down to 25 pounds, every well north of those is going to be down to 25 pounds, aren't they?

A. Well, the contours run less as we go north.

Q. They do?

A. They do. You say they would be less than 25 pounds?

Q. No, would also be 25 pounds—at least 25 pounds.

A. That is a reasonable assumption.

Q. It is an unavoidable conclusion, isn't it?

A. Assuming the pattern remains the same or approximately the same.

Q. All right, then, we have got it pretty well established that the pattern remains the same; that everything north of the present producing wells which are 2½ miles from the southernmost boundary, would be 25 pounds. All right, and we aren't drilling any more wells either.

Now, we established a while ago that if the pattern remains the same that when those wells are 25 pounds, that down at the edge of the field it would not be any more than —that is, in the area which is now shown as virgin—well, wait a minute. Strike all that.

Those wells are in the 410-pound isobar band, aren't they—that is, from 410 to 420? Those are the ones you said a while ago—the one over here (indicating).

A. Here is the 400, the 410 and 420 and 430.

Q. Then those southernmost wells have a pressure now of about 405 pounds as shown by the map, is that right?

A. I believe that is the case.

Q. "I think"?

A. All right, 405.

Q. 405 pounds, is that what you said?

A. Yes.

Q. All right, now, and you show for a portion of that

area southwest—*southweard* at least, a pressure now of 430 pounds, don't you?

A. Yes.

Q. The difference is 25 pounds, isn't it?

A. Yes.

Q. So when that well gets down—the well we are referring to which is the southernmost well in that quadrant —gets down to 400—I mean, gets down to 25 pounds, then the highest pressure on the southern side of your quadrant would be 50 pounds if the pattern remains the same?

A. That is indicated, and it also assumes that that isobar spacing is proportional—is truly proportional in the area immediate to the well.

Q. That's right, and the pattern is going to remain pretty much the same. All right, 50 pounds would be the very highest you would have south of that well, wouldn't it?

A. Disregarding those other factors, yes.

Q. And it would grade down by isobar line, by isobar line, down to 25 pounds; so your average would be a lot less than 50, wouldn't it, south of that line, to the southern extremity of the production; that is right, isn't it?

A. Your average, yes.

Q. All right, now, we have already agreed that everything north of that well will be down to 25 pounds because it is already much lower or gradually lower than that well to the north of it. That is correct, isn't it?

A. Yes, but between successive wells there will also be higher pressure areas than 25 pounds; so the very southernmost area isn't the only one to be considered.

Q. Now, when we have produced those wells that are in that quadrant now down to 25 pounds; then on the admissions you have just made, there is going to be practically no gas or very little gas left in that quadrant above your 25-pound abandonment pressure. Now, doesn't that naturally result?

A. Well, as you say, there is very little more.

Q. That's right.

A. It would be the amount of gas resulting from the increased pressures, whatever that amount of gas was.

Q. All right, we have demonstrated here I think that the highest pressure we would have would be 50 pounds.

A. And whether it is little or large depends upon that

degree of difference, and as indicated by the study, it is the difference between the reserves of the two estimates, one under wells and the other under leases.

Q. Well, now, as a matter of fact, from the very thing that we have just been talking about, Mr. Stevens, your estimate of recoverable reserves under Quadrant 1, Potter County, becomes and is an estimate of reserves under the leases in Quadrant 1, Potter County?

A. No, I have never maintained that or admitted it.

Q. I know you haven't admitted it, but the thing I am talking about, the figure which you got as being the gas recoverable from the wells is also the figure of the gas recoverable from the quadrant, under the leases.

A. Under the present wells as they are distributed only.

Q. Yes, sir, and all this we have been going through, we haven't drilled any more wells at all.

A. Well, you are presuming that all you ever want to recover is recoverable by these present wells and that is merely a matter of definition. Mr. Hammer's definition of leases presumes that you do recover the gas there is in there to recover.

Q. But Mr. Hammer's estimate may be wrong. Now, here is what we are getting to. Now, it is admitted—now, let's don't go back over it again—that whenever the well in that quadrant is down to 25 pounds that the highest pressure you will have in the quadrant down in the extreme southwest corner of it will be 50 pounds if the pattern remains the same.

A. And in other places between wells.

Q. All right, other places between wells it will be what?

A. That covers all the quadrant.

Q. I know, it will be what between wells?

A. That again is indeterminate, but you are going on the premise, Mr. Keffer, ~~if I may~~ say so, that if you had one well there that when you got it down to 25 pounds, that would be the reserve for the leases.

Q. It is the reserve for the leases if it drains the whole quadrant.

A. Well, but it won't.

Q. I know you said that a hundred times, but you have never given very convincing reasons to me why the wells in that quadrant today won't drain that quadrant, Mr. Stevens.

If you could answer me that question, we could cut all these questions that I have asked you this morning, if you would answer that one question.

A. These are tied in with practical things, finite time, the way you do things, hypothetical assumptions of one quadrant to the field. On your assumption you are about to make a conclusion or certainly imply that one well—all the gas that you could get out of that one well down to 25 pounds is the reserve of the field which is an absurdity on the face of it.

Q. I didn't make any assumption, but in fear that you may think I have, let's go back to Quadrant 1 we have been talking about. The wells are pretty well distributed over the quadrant, aren't they, and there is more than one well, isn't there?

A. Yes, and there are spaces between wells.

Q. How many wells in that quadrant? Look and see—39—there may be more now.

A. Well, that is approximately correct. There were 24 wells in the quadrant in which pressures were available.

Q. That's right, 24, and pretty well distributed over the quadrant, isn't that right?

A. Yes—well, I think so.

Q. Well, all right, take a look at it, Quadrant 1, Potter County.

A. The line across the northeast quarter—or the northwest quarter of the quadrant shows three wells and I don't see any northwest of that so that area is relatively—yes, I say the northwest quarter and the line running diagonally—yes, that is one of the three, but nevertheless, from the looks of it there are many locations if you consider the section as a drilling unit.

Q. All right.

A. There are many locations yet to be drilled in Potter 1.

Q. All right, now, answer my question. I don't know—you don't even consider a section a drilling unit, do you?

A. Well, they were on there for the purpose of comparison.

Q. How do you mean they were on there?

A. Wells were located in the center of sections, weren't they?

Q. I know, you've got to put it somewhere. The fact

that a well is located in the center of a section doesn't mean the section is a drilling unit, does it?

A. It doesn't, but the fact remains that there are considerably sized areas in Potter County that could logically drilled.

Q. All right, let's get away from sections as drilling units. The 24 wells in that quadrant are fairly evenly distributed over the quadrant except for the two or three miles on the south side of it.

A. South side and the northwest corner.

Q. Northwest corner, but you have wells in the northwest corner, haven't you?

A. I refer to the northwest corner as being the diagonal west half of the northwest quarter of the quadrant.

Q. Well, that would be about the northwest quarter, wouldn't it—half of a half is a quarter, isn't it?

A. That same area that is on that diagonal.

Q. Well, that might be about a quarter. That's close enough, anyway. All right. Now, I am going to apologize to everybody for staying on this so long.

You have far more wells per acre in Quadrant 1, Potter County, than you have in Quadrant 3, Potter County, haven't you, per acre?

A. I think that is true, there being only nine wells indicated here on Potter 3, that is right.

Q. Now, your nine wells in Quadrant 3, Potter County, by your own admission, is going to produce all the gas there and even a little more. That's right, isn't it?

A. Well, if you assume that you are comparing the reserves under leases and the reserves under wells as stated by the two exhibits.

Q. Now, I am getting away—yes, I am taking the reserves under leases as distinguished from the reserves under wells as you make the distinction.

A. Yes, we show those produce a little less than a fifth.

Q. That's right. You had over there a well that is in Quadrant 3—a well almost every 4,000 acres, didn't you?

A. I believe that was determined the other day.

Q. All right, now, what is your average well spacing in Quadrant 1, Potter County? Let's just compare them. Where are your acres?

A. I don't have the acres on here.

Q. Somebody give me the acres. It's in Mr. Hammer's exhibit. Do you know what it is?

A. No, I don't offhand.

Q. All right, look at Mr. Hammer's exhibit. Mr. Hammer's exhibit shows the acreage in that quadrant to be 57,588 acres, and you show 24 wells. That's right, isn't it?

A. I show 24 wells on which pressures were available to determine the pressures.

Q. There may be a few more wells now. I think there is, but we'll take 24 wells which you show. You have a little better than 2,000 acres to the well, haven't you—less than 2500 or about 2500?

A. 2400.

Q. All right, now, that's a lot closer spacing than you have over in Quadrant 3, Potter County, isn't it?

A. Yes, but two quadrants can't always be compared on spacing alone.

Q. That may be quite true, but the fact, nevertheless, remains you have a closer spacing in Quadrant 1, Potter County, than you do in Quadrant 3, Potter County?

A. That is right.

Q. All right, you say that the present spacing in Quadrant 3, Potter County, will produce all of the gas that Mr. Hammer shows under the leases and some over, don't you?

A. In Potter 3?

Q. That's right.

A. Yes, about a fifth more.

Q. How's that?

A. About one-fifth more.

Q. Yes, all right; then assuming other things are the same, it would be a very reasonable assumption to assume that a closer spacing in Quadrant 1, Potter County, would also produce all of the gas in that quadrant, wouldn't you?

A. If the comparison were based entirely on that criteria, that would be so, but your production doesn't show that.

Q. How do you mean "production doesn't show it"?

A. Production versus pressure, arriving at a recoverable reserve, and that recovery being compared to the reserve under the leases which—

Q. Now, you are going back to your answer for the pur-

pose of the comparison. Now, that's what I am objecting to. Maybe your answer is wrong. That is what I am objecting to. Let's don't go back and assume the answer and then check into it to see if you are right or wrong. We are trying to find the answer in this calculation.

A. The answer is indicated, as the answer shows, on the basis of production history. It is the answer and it isn't getting away from the fact that that is the answer and if the comparison is such as you say, that is just all there is to it.

Q. Now, you say—what is the answer?

A. Pardon me. Let me finish.

Q. Excuse me. Go ahead.

A. And it is all supportable. In fact, we think it has been adequately shown that the reserves under leases of Mr. Hammer's study is a minimum estimate, so the fact that—

The Trial Examiner: Just strike that portion from your answer. You go on and explain, but there is no reason for an answer like that. That isn't any part of the explanation.

The Witness: I'm sorry. I apologize to everybody, but I just did want to finish it. The fact that we show a reserve recoverable under the wells to be a little bit more than reserves under leases is supportable in our opinion as indicating a minimum estimate on the part of Mr. Hammer on another method and perhaps it should be pointed out again also that in making this, quadrant confines were observed, where in the other estimate the quadrant was determined as to reserve with respect to adjacent quadrants.

By Mr. Keffer:

Q. Well, I don't know whether that answers the question or not. Frankly, I've forgotten what I asked, but I believe you did answer. I'll shortcut here, if the Examiner please.

You did answer that if everything was the same that assuming similar conditions in Quadrant 3, Potter County, and Quadrant 1, Potter County, then your wells that are now located in Quadrant 1, Potter County, will produce all the gas that is there. I think you said that.

A. Potter County 1?

Q. Yes.

A. I thought you were talking about Quadrant 3.

Q. I say, if conditions in Quadrant 3, Potter County, and Quadrant 1, Potter County, are the same; then the number of wells now in Potter County 1 will produce all the gas in that quadrant.

A. Well, Potter County 3 was the one in which we had extensive discussion.

Q. Can you answer that question directly? I thought you already answered.

A. It will produce—let's put it this way: It will produce more than indicated by Mr. Hammer's reserve, but it still may produce—but it is entirely possible due to the effect of drainage in Moore County 3, it is entirely possible that more wells will be necessary in Potter County 3, so your conclusion is not fully supportable as to the particular condition there.

Q. Well, let's go back, then, to Potter County 3. Can you say to me that you have more drainage into Potter County 3 than you have out of it, looking at your map?

A. You can't evaluate it.

Q. Then you can't say, can you?

A. I have gone only on the basis of the record, Mr. Keffer, and to do otherwise—

Q. Just answer my question. You can say whether there has been drainage into Potter County, Quadrant 3, any more than there has been out of it, can't you?

A. I have not made a study of it.

Q. You just can't say, then. Just say you can't if you can't.

A. I can't.

Q. All right. That's all I want you to say. Since you can't say that, then you can't evaluate it and you can't give that as a reason logically.

A. I am trying simply to explain something that can't be explained with specific exactness, but only in principle, and it all goes back to previous earlier statements that this study is determined on what the record shows.

Q. Well, that is production record of wells, isn't it?

A. Yes, sir.

Q. All right, now, getting back to the question I asked you a while ago, assuming conditions are the same in the

two quadrants, Potter County 1 and Potter County 3, then you have enough wells already in No. 3, Potter, to produce all the gas that is there under the leases. That is right, isn't it? It would have to be.

A. Under the manner in which those reserves were determined, you might draw that as a conclusion, but it can't be concluded that absolutely no more wells will be necessary for the reason, I believe, that I just explained.

Q. On drainage. Was that your reason?

A. It may be drainage or whatever the reasons are, it is really immaterial. It is a fact that in Quadrant 3, as you say, the well distribution is—

Q. Not as good as it is in 1.

A. The territory—the Potter Quadrant 3 is not covered as completely by wells as is Potter 1.

Q. That's right.

A. And you have stated that it has impermeable areas in it.

Q. I have stated?

A. Yes, I think you claimed that it had impermeable areas in it.

Q. I didn't know I had. I have forgotten that I had.

A. If any rate could be considered comparable, as you are trying to make it, it is a conclusion that more wells could be drilled and probably should be drilled, and in which case the recoverable reserves would still be more than what it is over Mr. Hammer's method on the way he figured it, having in mind there the two methods of figuring, he including adjacent quadrants and I including only the quadrant in question, which makes a comparison of the figures entirely improper except on the broadest considerations, Mr. Keffer, and I think that answers the whole question.

Q. It makes it more difficult. You don't mean improper, exactly?

A. Well, the degree of difficulty almost makes it improper.

Q. All right, let's go a step further and see if I can't help you. You say you have got a good reason, but you don't know what it is. Let's see if I can help you get the reason. You would appreciate that, wouldn't you?

A. If you could evaluate the differences it would be, yes.

Q. All right, let's take Potter 1. See how your isobar lines run there? Can you see from there?—to the northeastward.

A. Yes.

Q. It indicates a rather rapid movement of gas, doesn't it, out of Potter County, Quadrant 1, to the northeastward?

A. I don't think it does.

Q. Well, all right. Now, let me ask you this: Now, on your method—now, I am talking about your method—you always come back to say that the records show this, the records show this, and the records show this. Now, on your method the records which you take are the production records, aren't they?

A. Yes.

Q. Plus the rock pressures, aren't they?

A. Yes.

Q. All right, now, let me ask you this simple direct question: If you have drainage out of a quadrant, then your production records as related to your rock pressure records will show a greater decline in rock pressures than you would have had if you had not had that drainage out, won't it? Just answer that. Anybody can answer that question.

A. That is right.

Q. That is right. All right. Consequently, on the way you have figured it you would show less ultimate production from every well in a quadrant of that character, wouldn't you, necessarily so?

A. If the drainage was occurring in the degree which you assume.

Q. Well, if it was occuring in any degree it is reflected there. You have said many times it is reflected.

A. It is reflected, that is right.

Q. Yes, sir.

A. But I believe you are assuming a marked degree, aren't you?

Q. No, sir, I am assuming the degree, whatever it is, as reflected in your figures. All right, now, the answer of that reflection, or the reflection, rather, that we get is that we get a higher drop in pressure per volume of production, and consequently, the way you have figured it, each well in that quadrant would produce less gas on your figures than if there had been no drainage. Now, that's just fundamental, isn't it?

A. That is correct, in principle, but this is what the record shows.

Q. I know, I am talking about the very record that you are talking about. The record as you have recorded it shows far less production per well than in the way you have figured it over any period in Quadrant 1, Potter County, than it does in Quadrant 3, Potter County, doesn't it?

A. Oh, you are comparing Potter 1. I thought you were talking about Potter 3.

Q. No, I say, the record as you have it shows that the value of a well in Quadrant 3, Potter County, is much more than it is in Quadrant 1, Potter County?

The Trial Examiner: From the standpoint of production?

Mr. Keffer: From the standpoint of production as compared to pressure drop. In other words, your pressures drop faster with the same volume of production in Quadrant 1, Potter County, than they do in Quadrant 3, Potter County.

The Witness: Well, they are down to—yes, there is a difference of about 14 pounds.

By Mr. Keffer:

Q. All right, now, the whole point is, your wells are dropping more rapidly in Quadrant 1, Potter County, than in Quadrant 3, Potter County, when *syncronized* with the production you are getting from the respective quadrants. Now, there isn't any question about that, is there?

A. That's right, but you omit an important consideration and that is the volume of gas that may be there, Mr. Keffer.

Q. Well, now, I don't know how much gas is there. I don't want to assume the answer on these. All right, now, let's go back to another angle on that, then: Your wells, because the pressure drop in Quadrant 3, Potter County, is slight compared to the production, but when you come—and by reason of that fact you come out above Mr. Hammer?

A. You say a slight pressure drop?

Q. As compared to the production, the volume of production.

A. The production is greater—is less in Potter 3 than it is in Potter 1.

Q. I know, but you have got a lot less area to the pound drop, and I haven't checked it. I am getting way out on a limb, but the pound drop in Quadrant 3, Potter County, is less when related to production than it is in Quadrant 1, Potter County, isn't it?

A. Well, let me see.

Q. I am trying to help you solve this thing that you can't understand, and maybe it won't solve it.

A. Potter 1 has a greater area, is that right?

Q. Oh, yes, of course.

A. And you say it has a greater production per pound than does Potter 3?

Q. No, I say Potter 3 has a greater production per pound drop than does—

A. Well, I'll have to investigate that.

Q. How's that?

A. I think we ought to investigate that.

Q. All right, can we do that real quickly? Now, here is the thing I am basing it on. Now, see if I am not right. Now, you get a lot more—as you have figured it here you get a lot more production per well in Quadrant 3, Potter County, than you do in Quadrant 1, Potter, and if that is true, I can't see any other answer to it except the production drop.

A. I think we are confusing—we are talking about two or three different units in diverse areas and now we are getting into production per well, and we are getting to a point where we just can't answer anything. I think we ought to investigate those before we make any more of an answer.

Q. Well, let's see right here, maybe we can get it here.

A. Potter 1, 38 billion.

Q. That's accumulated?

A. Yes, but we can consider it under total pounds produced.

The Trial Examiner: The hearing will stand in recess for five minutes.

(At this point a short recess was taken, after which proceedings were resumed as follows:)

The Trial Examiner: The hearing will be in order.

By Mr. Keffer:

Q. All right, now, Mr. Stevens, you had on your work sheet here the matter that we were discussing a moment ago. Now let's see if we can't hurry through this. I'll read from this sheet and you say if it is correct or not.

In Potter County 1 your total production in 1939—

A. 1939—I just figured these out by total.

Q. I know, but I don't want it that way. Your total production in 1939, 11,214,000,000 feet, wasn't it?

A. Yes.

Q. Your decline in rock pressure for that same period was eight pounds, wasn't it?

A. Yes.

Q. All right, now, we come over to Potter County, Quadrant 3. All right and your production from Potter County, quadrant 3 was 5,225,000,000, wasn't it?

A. Yes.

Q. Your decline in rock pressure was four pounds, wasn't it?

A. 4.3 billions per pound.

Q. All right, now, let's take another view of it. The Canadian River production in Potter County, Quadrant 1, was 6,712,000,000 wasn't it?

A. Yes.

Q. All right, that is slightly more than Canadian River's production in Potter County, Quadrant 3?

A. Yes.

Q. You had a 4-pound drop in Potter County, Quadrant 3, as against an 8-pound drop average in the Potter County, Quadrant 1, with very little more production by Canadian River in Potter County, Quadrant 1, is that correct?

A. That is correct on the basis of total quadrant pressures; however, when you start to compare—make a comparison, a basis of comparison, with Canadian River Gas Company, you should consider the pressures of Canadian River Gas Company.

Q. What are the pressures of Canadian River Gas Company's wells in that area, the drop in pressure in the two years?

A. Between 1938 and 1939?

Q. Yes. It would still be about 8 pounds, wouldn't it?

A. I don't know. They are considerably higher than the quadrant average.

Q. Do you know that to be a fact?

A. Yes.

Q. All right.

A. Mr. Watson, I believe, stated there was 375 pounds in 1939.

Q. In Quadrant 1?

A. Not quadrant 1.

Q. And it was all Canadian River?

A. All Canadian River.

Q. You are bound to have that somewhere there. If you will give it to me I will have it computed and bring it back to you for comparison.

A. Of course, they are all on these work sheets but they are computed to an average.

Q. All right, let us assume, while checking it, that the per pound drop of Canadian River production in Quadrant 1, Potter County, was about 8 pounds from 1938 to 1939.

A. Yes.

Q. All right, in Quadrant 3, Potter County, it was 4 pounds—that was 4 pounds as you show it in there from 1938 to 1939?

A. If you make it clear that this assumption of pressure loss is on the basis of the total quadrants which contain at least three and one-half times more wells than does Canadian River alone, and they are lower pressured wells, and a comparison on the basis of quadrant pressures apply to Canadian River production is not tenable, Mr. Keffer. You have to compare like—

Q. We are going to compare Canadian River's production. That is what we are checking now.

A. You refer to this 4-pound drop. That is the total—

Q. That is all Canadian River. Nobody has anything else in Quadrant 3—

A. I beg your pardon. That is right as to Quadrant 3.

Q. On Quadrant 1 we are going to take it on Canadian River wells alone.

A. Yes.

Q. Let us proceed. Whenever you have that sort of a situation, Mr. Stevens, that is, where the pressure—all right. Here we have it right here. The pressure drop on

Canadian River wells in Potter County, Quadrant 1, 1938 to 1939 was 11 pounds. That is more than your quadrant average, isn't it?

A. Yes, 11 pounds.

Q. 11 pounds. In Potter County, Quadrant 3, it was 4 pounds, wasn't it?

A. All right.

Q. Will you figure out the production per pound pressure drop in the two quadrants and compare them? In fact, you can do that ~~almost~~ in your mind.

A. On Canadian River production and Canadian River pressures?

Q. Yes, that is right. You take Quadrant 3 where you have a production of 5,351,000,000 with 4 pounds drop. Divide 4 in to that and you have about 1 billion 3, don't you?

A. Over here you must consider Canadian River production 6.712 with an 11-pound drop.

Q. How much did you have there per pound drop in pressure?

A. .61 billion per pound.

Q. .61 billion per pound? It is bound to be a lot less than that. It must be 671. This is in billions and you divided by approximately 10, and as the result you got .6.

Q. It wouldn't be 6 billion, it would be 671—I see.

A. That is correct.

Q. You had .672 billion?

A. 6.712 and you divided by 11.

Q. You couldn't still have 6 something, could you?

A. I said .6.

Q. I beg your pardon. I thought you had your 6 and then your point. You are right. Then your production per pound drop on Canadian River's wells in Potter County, Quadrant 1, is .617 billion, is that right?

A. Potter County, Quadrant 1, yes.

Q. And in Quadrant 3, Potter County, it is 1.3?

A. Yes.

Q. So your pressure is dropping twice as rapidly in Quadrant 1, Potter County, compared to your production than it is in Quadrant 3, Potter County, isn't it?

A. Let's see. We get less production per pound in Potter County, Quadrant 1, than we do in Potter County, Quadrant 3.

Q. That is right.

A. We get less production per pound in Potter County, Quadrant 1, than we do in Potter County, Quadrant 3.

Q. In fact, you get just about half as much in Potter County, Quadrant 1, as in Potter County, Quadrant 3.

A. That is right, and that is exactly as it should be.

Q. Why is that exactly as it should be?

A. For the reason that in Potter County, Quadrant 3 you have both a larger area and a larger number of wells taken from a larger size tank, as it were, and the larger size tank, if it can be referred to as a tank for simplicity, will give you more production per pound than will a smaller sized tank because it is simply—

Q. It will give you more, but you get less in that large tank, don't you, just half as much as you did in the smaller tank?

A. Potter County, Quadrant 3, is a larger tank than Tank 1.

Q. Potter County, Quadrant 3, is larger than Tank 1? I think you are way off on that.

A. I beg your pardon. Well, it gives the difference in that case could only be accounted for by the volume of gas in there.

Q. The volume of gas where?

A. I was assuming for the moment that the areal size might be an indication of the total volume of sand or something.

Q. If it was an indication when you made this assumption, it is still an indication, isn't it?

A. It isn't—

Q. Answer me. Isn't that a fact? If you made a correct assumption a while ago it is still correct right now, isn't it?

A. Well,—

Q. Answer me. Just say yes or no.

A. It is not restricted as you are trying to restrict it.

Q. I am not trying to restrict it. I am making the very simple statement you made—

Mr. March: I object to the witness answering the questions *extemperaneously*. They are unfair to us and unfair to the witness.

Mr. Keffer: There is nothing *extemperaneous* about this.

The Witness: You tell me—

Mr. March: He makes the witness figure out the problems as he goes.

The Trial Examiner: This particular cross examination, Mr. March, is directed to a voluntary statement made by Mr. Stevens. It certainly is permissible. If Mr. Stevens is going to insist upon volunteering these statements, I can't prevent Mr. Keffer from questioning him about them.

Mr. March: The fact is he volunteered to work out the problem here.

The Trial Examiner: No, no.

By Mr. Keffer:

Q. Mr. Stevens, you said there ought to be more production per pound drop in pressure in Quadrant 3, Potter County than in Quadrant 1, Potter County,—

A. That is the thing—

Q. Wait a minute, let me finish my question.

—because Quadrant 3 was so much larger than Quadrant 1, and you had a bigger tank to produce from, therefore, the production should be more per pound drop. Now, if that were true then, it is true right now, isn't it?

A. If it were true then—

Q. You made an untrue statement when you said that, did you not?

A. I assumed, as I started to explain that if the areal distribution is the only criterian involved as indicating the size of the thing, that is the relation indicated to be expected—

Q. When you found it worked just the opposite, you wanted to abandon that one, didn't you?

A. You have to—I did it for this reason: If that isn't apparently the criterian, the surface area as indicated by the map alone, then something else must apply, and I was attempting to state that.

Q. What is the "something else"?

A. Without knowing the exact producing thickness of Potter County, Quadrant 3, the smaller one, as compared with Potter County, Quadrant 1, the larger one, it is impossible, of course, to define whether that particular thickness

may be the accounting difference, the difference accounting for—

Q. What you say, then, is that you have more gas per acre—

The Trial Examiner: Wait a minute.

Mr. Keffer: I beg your pardon.

The Witness: The other thing that accounts in part, without attempting to name the degree for the larger production per pound in Potter County, Quadrant 3, is occasioned certainly in some degree by the drainage from Moore County, Quadrant 3. The combination of those, or whatever else may have occasioned it, is obviously an explanation for the difference, and what those other things are is not contemplated in the study; I don't even care what they are.

By Mr. Keffer:

Q. You just don't know what they are?

A. We don't know what they are in degree, no, sir, as stated before.

Q. All right, suppose the productivity of Quadrant 1, Potter County, per acre was greater than it was in Quadrant 3, Potter County; that is, it is just a richer producing area, would that have anything to do with it?

A. If it were a richer producing area?

Q. Yes, if Potter County, Quadrant 3, were a richer producing area—I mean, Potter County, Quadrant 1, were a richer producing area than Potter County, Quadrant 3, would that have anything to do with it?

A. (Pause.)

Q. Just answer it without looking at your answer there before you first.

A. That is—

Q. All right, look at it.

A. You are dealing with thickness of sand and the early extent of that thickness—in other words, the size of the tank.

Q. That is right.

A. The size of the tank consisting of sand and thickness of sand undoubtedly has some bearing in it, so it wasn't part of this study, Mr. Keffer.

Q. Right there, if the size of the tank, or in other words the richness of the area was greater in Potter County,

Quadrant 1 than it was in Potter County, Quadrant 3, then you would expect a smaller decline per pound with respect to the same production as compared to production than you would in Potter County, Quadrant 3, wouldn't you?

A. A smaller production per pound?

Q. You would expect—no, you would expect a larger production per pound drop from a richer area than you would from an area that was not quite so rich?

A. That is possibly true, but they are indicated not to be that rich.

Q. In fact, they indicate the reverse, don't they?

A. Yes.

Q. All right.

A. You were asking me to evaluate that difference in proportion—

Q. You were just saying you couldn't evaluate it and I am trying to help you. I am trying to do you a favor.

Mr. March: This is a good example of the cross examination. He said that he couldn't do it and he said he would help him—

Mr. Keffer: The point is, he has evaluated it and that is the only thing I am coming up to.

The Trial Examiner: Objection overruled.

By Mr. Keffer:

Q. Mr. Stevens, the map here shows 22,279,000 recoverable reserves per acre in Quadrant 1, Potter County, doesn't it?

A. You are reading from the map?

Q. Yes. Look at it and check it.

A. The remaining reserves on a weighted basis.

Q. What weighted basis?

A. The weighted basis Mr. Hammer used.

Q. Mr. Hammer on the same basis shows 13,426,000 per acre remaining in Quadrant 3, Potter County, doesn't he?

A. Yes, he does.

Q. So everything we have mentioned so far, producing thickness of sands, size of tank, or container, richness of production, all should operate in favor of Potter County, Quadrant 1?

A. Just on the face of it, yes, but—

Q. Just the reverse—

A. I—

Q. Excuse me. Go ahead.

A. It is necessary again to point out the difference in the method used by Mr. Hammer and myself, he incorporating the adjacent quadrants which I did not do.

Q. However, the reverse of those things are true, aren't they?

A. Indicated by these figures—

Q. Indicated by these figures which you yourself prepared?

A. But the effect of the drainage into Potter County, Quadrant 3, from Moore County, Quadrant 3, you haven't given that any consideration.

Q. All right, have you given any consideration to the drainage out of Potter County, Quadrant 1?

A. Except as it is incorporated in the figures.

Q. All right. Precisely so, how is it incorporated in the figures?

A. In whatever degree it affects it.

Q. In pressure loss?

A. In Potter County, Quadrant 1?

Q. Yes. That is right. That is the only way it could be incorporated in your figures for drop in pressure, isn't it?

A. Yes.

Q. That is right. Now, you take that drop in pressure, if you didn't have any migration out your would have had a lesser drop in pressure than you would have had if there was no migration out, wouldn't you?

A. That is—

Q. It is obviously so.

A. It is a statement of principle.

Q. There shouldn't be any argument about that, should there?

A. That's right.

Q. Now, all of the factors you have been naming that should explain this difference, the fact it is working in reverse order, which is somewhat a definite indication you are getting a much less production per pound drop in Quadrant 1, Potter County, than you are in Quadrant 3, Potter County, because of the loss of gas from Quadrant 1 by underground drainage, isn't that a fact?

A. If you divorce the question entirely from thickness, and so on, that would be because—

Q. Including thickness. We have more thickness on your own statement in Potter County, Quadrant 1, than on Potter County, Quadrant 3.

A. As to whether this is occasioned by local drainage, the map would probably serve as the best criterion to answer that, and that is Mr. Hammer's exhibit.

Q. All right, I am going to finish on this.

You show in Potter County, Quadrant 1, present wells are going to produce 340,500,000,000 cubic feet of gas, don't you?

A. Yes.

Q. You show, or Mr. Hammer shows, that the total amount of gas under the leases in that area is 1,078,766.000, doesn't it?

A. Yes.

Q. You show, then, under the present wells we are not going to produce more than a third of the gas that is under that lease, don't you?

A. Under present wells, yes, sir.

Q. Under present wells. You show a greater concentration of wells in that quadrant than you do in Quadrant 3, Potter County, or any other portion of Canadian River's total quadrants, don't you?

A. Yes, but we also pointed out that there was room for more drilling, which indicates room for more wells, and that those wells we added would necessarily add to accessibility of reserves.

Q. All right. You mean that we can step up our production and cut down drainage? Is that what you are trying to say?

A. You could step up your recoverable reserves by drilling more wells. That is all I am attempting to say.

Q. I am trying to go very rapidly, Mr. Stevens, but this is an important point, one of the most important ones in this entire question of reserves.

Your own figures as you have made them show that from the standpoint of the present wells in Quadrant 1, Potter County, that we are only going to produce one-third of the gas in that quadrant, don't they?

A. ~~That is right.~~

Q. That is absolutely correct. All right, now, if those present wells—and there are 24 of them—are sufficient to drain that quadrant of its gas, then you have calculated not qualitatively but quantitatively by your own figures the amount of gas that is going to be lost from that quadrant by drainage over 600 billion feet or two-thirds of it, haven't you?

A. It is indicated there are not enough wells in there to drain that quadrant. That is the point in the matter.

Q. You say it is indicated because those wells are only going to produce 340 billion while it is shown there is over a trillion there. That is the way you say it is indicated and that is the only proof you have that it is indicated?

A. On the basis of the study, that is right.

Q. You say it is indicated because you take your answer and figure back down, don't you, and that is the only proof you have of it?

A. You draw the conclusion from the answer as you do in any problem.

Q. All right. Now, as a matter of fact, if those wells are only going to produce 340 billion cubic feet and there is more than a trillion cubic feet there then is it not a logical assumption that we are going to lose two-thirds of that as the result of underground drainage from your own calculations?

A. No, the conclusion is that you need to drill more wells and that is the only conclusion.

Q. You are shutting your eyes to drainage, aren't you?

A. Except as they are incorporated in the figures.

Q. I have cited your figures. That abnormal drop in pressure with respect to production as compared to other areas where the reverse ought to be true. What more do you want than that, Mr. Stevens, as an engineer, geologist or as an ordinary layman?

A. Well, to me it simply raises the question that—simply points to the conclusion that more wells are necessary—

Q. You say it simply points to the conclusion that more wells are necessary, because you are assuming there will be no drainage. Let's get on the other side a minute.

A. I haven't assumed drainage in any case. I have admitted local drainage where local drainage is located and I think it is from this point or the point of view of drainage

locally a matter for the company to consider whether they drill wells to reduce that local drainage. The point is that the gas is there and this will be the recoverable gas by these present wells, and if there is drainage you separate your drainage if you claim there is drainage or you know there is drainage—

Q. Maybe so. You say that these wells when they are down to 25 pounds, wells that are pretty well scattered over the quadrant, will have produced only 340 billion feet of gas. Now, you have said that without any quibbling, haven't you?

A. Yes.

Q. That is in your report. You have also said that when those 24 wells are down to about 25 pounds that practically all of the gas in that quadrant is going to be done, haven't you?

A. Except as is retained in higher pressure intermediate areas.

Q. And you said you thought if the same pattern continues, 50 pounds would be the highest pressure anywhere in it, and that in the southwest corner. You said that, didn't you?

A. We have assumed that 50 pounds pressure is an arithmetical subtraction. It may be local; it may not be. There is good reason to believe it will be over 50 pounds, probably a little better reason than to assume it is 50 pounds.

Q. It is not going to be two-thirds of 430 pounds, is it?

A. I don't know what it will be.

Q. That is what you are going to have to make your figures come out, isn't it? You will have to have the average all over it. You would have to have big slices of the virgin pressure to have over 600 billion left in there after you produced 340 billion, wouldn't you? You would have to have two-thirds of your pressure left when every well in the area was down to 25 pounds and you know very well that is an absurdity, don't you?

A. I think we are getting away—

Q. Answer me if that wouldn't be an absurdity.

A. As you stated it it would.

Q. I have stated it precisely as you calculated it, haven't I? I haven't deviated an iota from your calculation, have I?

A. I think it should be pointed out again that this figure

means that on the basis of your present wells you will recover this 340 billion.

Q. That is right; which is a third, approximately, of the remaining reserves, isn't it?

A. About a third of the figure given by Mr. Hammer.

Q. If you wanted to qualify his estimate, I will qualify it—

Mr. March: I object to haranguing with the witness.

Mr. Keffer: It was just a side remark—

The Trial Examiner: We will strike it. Go ahead.

The Witness: When we get right down to it, this estimate means—I think it is true that Mr. Hammer's estimate means that that is the gas that is under there. This is the gas that would be recovered by present wells. The difference between that third figure and that figure given as one-third in relation to Mr. Hammer's; in other words, the two-thirds, is the amount that you could get additional by drilling additional wells.

By Mr. Keffer:

Q. All right. Right there, I have just another question there, and I think we can make that very clear.

You say that the present wells would produce in round figures a third of what Mr. Hammer says is there remaining down to 25 pounds abandonment, don't you? That is what your figures show?

A. Yes.

Q. All right. Now, it would follow that when you have produced that one-third and every one of those 24 wells are down to 25 pounds, then for you to have two-thirds of it left, you would have to have two-thirds of that pressure, wouldn't you?

A. You would have to have two-thirds of the pressure left but you are saying there is no drainage from there—

Q. Wait a minute. You are saying there was not—

A. I didn't say there was not.

Q. All right. Then, you now say there was some drainage from there?

A. I believe on one side there is some local drainage.

Q. All right, but is there any difference between local drainage and any other kind of drainage?

A. Regardless of what happens, drainage or no drainage —you say "drainage." I believe it has in Potter County, Quadrant 1. I believe some local drainage was established for Potter County, Quadrant 1. It doesn't mean in those immediate areas it is going to be two-thirds of the pressure; it means on the basis of this record you are going to get this gas.

Q. That is right. On the basis of your calculation you say if we drill a certain number of additional wells and we have so much reserve for such wells you are finally going to get over a trillion feet in Quadrant 1, Potter County?

A. If you would drill sufficient wells in the quadrant you would get a trillion feet.

Q. You don't know how many wells that would be?

A. I haven't attempted to state.

Q. You also say "when we have produced 340 billion, or a third from our present wells every one of those present wells are going to be down to 25 pounds abandonment pressure," don't you?

A. Their average will be 25. That is the equivalent of stating that.

Q. I will take that qualification.

If the average of every one of those wells, every one averaged in is down to 25 pounds, there couldn't have been but very little—I will say 10 per cent more gas remaining in the higher pressured portion of the quadrants; that is, between 25 pounds and that higher point?

A. I don't know how you figured the 10 per cent. I can't check it.

Q. I picked the figure out of the air. It couldn't be very much, isn't that right?

A. As to "very much," very much is a relative matter.

Q. I know. You can state it in general terms that there isn't going to be much gas. I think anybody could state that.

A. Let me state it this way: If in a given place you had 25 pounds in some illustration and you used 50 pounds, that 50 is 100 per cent more than 25 in that case.

Q. All right.

A. So if you were talking about 10 per cent and I were to check you on 10 per cent, that would be a pound and a half or a pound and a quarter more, which is a little bit peculiar.

Q. When every one of your wells are down to 25 pounds, certainly you are being very generous when you assume that the pressure over the entire area would be more than fifty pounds on an average, wouldn't you?

A. I don't know what it would be.

Q. I know you don't know what it would be, but that would be a most generous estimate, wouldn't it?

A. If—

Q. You can answer that question.

A. You can't without considering one point, that that last 25 pounds differential is going to be a lot harder to get—a reduction in pressure, that is, a flattening to the difference of 25 pounds you have stated, is going to be a lot harder to get than any other set of differentials of 25 pounds.

Q. That is right. Even on any other theory you are not going to get it down to 25 pounds, are you?

A. That is right.

Q. I don't care if you drill a hundred more wells, you are not going to get it down to 25 pounds, are you?

A. Not minutely speaking.

Q. Of course not. Then when you figured there was so much left there at 25 pounds you have to make some adjustment for that that you are not going to get, regardless of how many wells you are going to drill?

A. What adjustments?

Q. There is something more than 25 pounds in there you are never going to get because of these pressure differentials?

A. That brings you to the point of what 25 pounds means.

Q. I assumed 25 pounds meant 25 pounds.

A. We have talked about it in regard to 25 pounds at the well head.

Q. That is true. You said a 25-pound well head all through the examination, so it means just that and not something else?

A. These figures, if you treat them strictly, mean an average of 25 pounds, that is true.

Q. At the well head?

A. At the well head.

Q. That is right. All right, go ahead.

A. The difference between 25 pounds and what the actual pressure would be, if you were able to find that and average

it out, if it were possible to average every square foot of it, that difference in pressure represents an additional amount of gas that isn't contemplated here.

Q. Well, I know. We needn't go into that. When you have 25 pounds well head, if you are going to produce any gas you have to have something more than 25 pounds out away from the well. That is simply stated and is the whole thing, isn't it?

A. That is true.

Q. All right, so when you say "recoverable down to 25 pounds well head," then you have to make some adjustment for that somewhat higher pressure out from your well, which you are not going to recover down to 25 pounds well head, are you?

A. I see your point, but that 25 pounds is—all of these other pressures we have are actually higher than we have stated for the same reason.

Q. What do you mean by higher?

A. They lack a degree of equalization to a stabilized point just as they will at 25 pounds, so they are all off to that extent.

Q. Your 430 pounds had no variation?

A. This 4-year period hasn't anything to do with this 430 pounds.

Q. I know, but in taking pressures today and figuring them back against 430, it has something to do, doesn't it? If they were off in 1935 they would still be off in 1939, and in about the same proportion in all probability, so the result is the same whether they were constant or off, isn't that right?

A. I think so.

Q. I don't think there is any argument about it. I am going to leave that. Just this one question:

You said if you had been estimating reserves you would have followed Mr. Hammer's method, is that right?

A. Reserves under leases, yes.

Q. Reserves under leases?

A. Yes.

Q. Do you know what his method was?

A. In general I have heard him describe it here.

Q. You are not so certain you would follow it if you didn't know precisely what it was?

A. As I understand it—it has been presented here—
Q. I am going to ask you one thing about it, then.

His method averaged or weighted rock pressure averages from an areal standpoint, didn't it, with respect to area?

A. Yes.
Q. Let me ask you this: Where there are volumes, as announced by Boyle's law, that vary with pressures; that is, the pressures vary with volumes or areas? Just state Boyle's law. Maybe I have it backwards, I don't know.

Mr. March: The question is that you want him to state Boyle's law?

Mr. Keffer: The question is that the pressure varies with volumes.

The Witness: I thought you referred to a deviation from Boyle's law.

Mr. Keffer: No.

Q. Boyle's law, from a grammar definition of it, is that pressures vary with volumes, isn't that right?
A. Yes.
Q. And the pressures do not vary with areas, do they?
A. The manner in which you used pressures and areas—
Q. Mr. Boyle didn't say anything about area when talking about the varying of pressures, did he?
A. Pressures can be weighted against any factor pertinent to those pressures.
Q. The point is, volume is the pertinent thing to weight with the pressures and not areas; that is the whole point. You hit it on the nail head—
A. Those volumes occupy areas and in a sense are synonymous with areas.
Q. Volumes are synonymous with areas?
A. Well, when you talk about an acre pound volume, you are talking about a volume in an acre.
Q. All right, I am going to get away from that in just a minute. If we knew the volume under every one of those areas and weighted pressures to that volume, we would get a perfect answer under the application of Boyle's law, wouldn't we?

A. Yes.

Q. All right, now, just one more question further.

When we don't know the volumes and we take the areas and weight it that way, we are necessarily giving every area the same volume, aren't we, in that sort of a weighting?

A. When you consider areas, you are in effect considering the volume under that area.

Q. But you are considering every area has the same volume, aren't you?

A. Within certain limitations.

Q. What do you mean by "within certain limitations"?

A. That is the effect of volume differences in the area in question as weighted into the pressure.

Q. How?

A. In that sense, while you reduce your figure to an area, you are incorporating the *varities* or the divergent characteristics, the differing characteristics of those areas into one quadrant, the area being the acre pound for the quadrant. It is obviously understood that without wells on every square foot you couldn't do it on a square foot basis.

* * * * *

Q. When you are averaging pressures against acreage you are omitting one of the fundamental principles of Boyle's law, aren't you?

A. I don't know what principle you mean.

Q. The principle that pressures vary with volumes and not with areas.

A. I believe I answered that in this manner, that the volumes taken out under those areas, the volumes you omit are of course a part of the expression of Boyle's law.

Q. When you are weighting pressures against acreage, when do you consider the volumes taken out with respect to each particular year? How do you consider it?

A. That—

Q. The fact is, you don't consider it, do you?

A. Don't consider what?

Q. Volume as related to each particular area between isobars on the map.

A. Those are weighted to a single area and in that respect they do.

Q. In that respect they do. You take area 1 which lies between any two isobar lines and you have a pressure of 400 pounds, we will say. You multiply that by the acreage, don't you?

A. Yes.

Q. You come to area 2 that has 390 pounds. You multiply that 390 pounds by the acreage, don't you?

A. Yes.

Q. You come to area 3 which has 380 pounds. You multiply that by acreage, don't you?

A. Yes.

Q. And then you add all of those up, don't you, all the way through the field?

A. Yes.

Q. And you divided by the number of acres to get your weighted pressure?

A. Yes.

Q. And you haven't considered volume in one single instance, have you?

A. What you have done—

Q. Answer my question. You haven't considered volume in a single instance, have you?

Mr. March: Let him answer the question.

Mr. Keffer: He can answer the question yes or no.

Mr. March: He can explain it.

Mr. Keffer: He can answer the question yes or no, and then he can explain it.

The Trial Examiner: Answer the question.

The Witness: No, with this explanation—

By Mr. Keffer:

Q. Go ahead.

A. —that you are right there at the point where you have not considered volume. What you have done to that point is that you have weighted the diverse points of that area under those contour—

Q. Weighted acreage against pressure, haven't you?

A. Yes.

Q. And not volume, have you?

A. But—
Q. Not volume?
A. Not at this point.
Q. All right.
A. And at that point when you do obtain that weighted pressure you have reduced those numerous tanks of 10-pound pressure differences, we will say—that is a good illustration —to what the pressure would be as nearly as can be figured if the entire series of tanks or quadrants were used to full equalization. That is the nearest approximation of it and that is the point that you have arrived at at this point. The next point is to—in other words, you have determined a pressure or the very best possible pressure representing that area having diverse components and with that you treat volumes and that is the way Boyle's law works.
Q. You treat the volume after you get the average? You didn't treat volume before you got the average?
A. It isn't my understanding that volume worked in at that particular point—
Q. Of course not. Now, when you do it that way you are considering that all areas have the same volume, aren't you?
A. I consider all areas have the same volume?
Q. Yes.
A. All areas have the same volume?
Q. That is right.
A. I think Mr. Hammer ought to answer that point.
Q. You can answer it. You are familiar with how you do it.
A. At this point we have weighted average pressures against acreage which is the effect of making one tank out of numerous diverse tanks.
Q. From an areal standpoint?
A. From an areal standpoint.
Q. But not from a volume standpoint?
A. The whole volume—
Q. But not from a volume standpoint?
A. That is right. That has been admitted.

At that point the volume of gas is considered, as I understand it—If I am wrong I don't want to be bound by this, naturally—the volume is considered to have come from that one tank so treated, and if you had 5-pound isobars or

1/10-pound isobars, if it were possible to make those, the degree of refinement would be greatly increased.

If you had lesser distances as employed by many people, your degree of refinement would be a great deal less. As I understand it, that is subject to correction by Mr. Hammer on his own behalf. That is my understanding of the matter.

Q. All right. The whole point is when you weight pressures against acreage you are not following Boyle's law strictly? The obvious answer is yes to that.

Mr. March: You don't have to put the answer in his mouth. Let the witness answer the question.

Mr. Keffer: All right.

The Witness: You are following Boyle's law in that you are merely preparing the data to a convenient form for the application of Boyle's law, and the process isn't through until you use volume. Certainly the use of pressure versus volume is an expression of Boyle's law, so therefore I don't understand why you don't use Boyle's law.

Mr. Keffer: All right.

Mr. March: It is an old trick of Mr. Keffer to jump from the assumption to a practical thing and accuse the witness of having done that himself.

The Trial Examiner: I think we are proceeding under the assumption as originally stated by Mr. Keffer.

Mr. Keffer: That is right.

The Witness: We have an assumption where there is a high pressure area that does have some gas in it, though there is no well drilled on it.

By Mr. Keffer:

Q. Just how much volume would you assign to that area and how would you go about it?

The Trial Examiner: You are still speaking of an area having a 430-pound pressure without any gas in it?

Mr. Keffer: I will say there is a half-million cubic feet of gas per acre—

Mr. March: Wait a minute. Let me see here. First Mr.

Keffer takes this assumption, the assumption that we have an area that doesn't have any gas in it, yet it has 430 pounds pressure. That is Mr. Keffer's own assumption.

The Trial Examiner: That is right.

Mr. Keffer: Mr. March, if you will sit down I will change it.

Q. We have an area with 430 pounds pressure that has a half-million cubic feet per acre in it. How much volume are you going to assign to that under your method of estimating reserves?

A. If you knew that you had a half-million—

Q. We don't know it. We are assigning that.

A. The rest of the components of the problem haven't been stated and as I understand the method. Incidentally, I think I should say that not having made this study under this method, in spite of the fact that I say that I would have used the method, being in a position to use the method at some time, I would certainly go into a study of details which probably at the moment I have not fully considered. Not having gone into a study of it: therefore, I feel that answers I make under this hypothetical situation should be made with the reservation that they are all connected in principle.

Mr. Keffer: I wish the Examiner would please look at Mr. Stevens' exhibit, the first graph in that exhibit, which is the composite graph.

Q. Now, Mr. Stevens stated quite positively to Mr. March yesterday that you couldn't have drawn a line through or near the circles 1937, 1938 and 1939, which are circles around your points, without showing more reserve instead of less reserve. You made that very statement, didn't you?

A. Based upon the judgment of the time I drew the line.

Q. You made the very positive statement that on that curve you had given 1939 as much weight as you gave 1937?

A. As I gave 1937.

Q. You gave 1939 as much pressure as you gave 1937; you made that positive statement, as I recall it.

A. I perhaps did, if you say so.

Q. That is when I interjected yesterday—

Mr. March: Mr. Examiner, I object. If the witness doesn't know, he can say he doesn't know. He doesn't have to assume anything that Mr. Keffer says.

Mr. Keffer: The record speaks for itself.

The Trial Examiner: Go ahead.

The Witness: In an extension of this kind, as in subsequent cases, if I haven't made it definite I want to now, all points were considered in giving weight where at all such weight was justified, the exception being one or two where 1937 was way off.

By Mr. Keffer:

Q. To get back to my question, you want to let your answer stand that you made directly to Mr. March yesterday that you had drawn the most conservative line you could draw taking into account 1937, 1938 and 1939?

A. I think that is right. I think that is an honest statement.

The Trial Examiner: Did you mean, Mr. Stevens, that you didn't want that answer to stand, or you wanted it to stand?

The Witness: I wanted it to stand with reference to these three points, with the very slight qualification—not "qualification," "clarification" that it is an honest statement.

Mr. Keffer: I intended to go over these one by one but time will not permit.

Q. Suppose you leave that line right where it is, just clearing the south side of the circle numbered 38. Do you see that point?

A. Yes.

Q. Then you tilted your line a little to the northward out at 1937 to where it just barely touched the outside of the circle 1937, you could do that, couldn't you?

A. You could.

Q. Then you tilted it down necessarily when you tilted it up with 1938 as the pivot; and when you pivoted it up at 1937 you naturally tilted it down to 1939?

A. Yes.

Q. Do you know where you would barely touch the rim of the circle at 1939?

A. You could do that.

Q. Wouldn't that be a more accurate reflection of the circles 1937, 1938 and 1939, than the line you have drawn?

A. I am not sure. I would have to call your attention to another possibility—

Q. Just answer my question. You can answer it. You don't need a microscope to see it.

A. That, Mr. Keffer, is one possible way to have drawn it.

Q. When you made the positive statement you couldn't have drawn that line any other way, taking the three points into account without showing more reserve, you didn't state the truth, to make it blunt, did you?

A. I stated the truth in this respect—

Q. Part of the truth, then. All right, go ahead.

Mr. March: I object, Mr. Examiner. We don't like these insinuations in the record.

Mr. Keffer: Strike that part of it.

The Witness: The truth to you, rather to me—let me put it that way, as I don't know what the truth is to you—is that at the time of drawing that line it represented a very equitable way to draw that line. It should be also mentioned that each of the following lines with one admitted exception in which it could have been drawn another way, and that variation when we get to it will seem very small in a reduction of reserve. The other quadrants could not have been changed in any reasonable manner, giving due regard to all three points without increasing the reserve, and it is to be noted again that the results for the total quadrants of the Canadian River are the result of a summation, and this summation is shown here now. If this summation of equitably and conservatively drawn components comes to the point of being expressed by a line which falls in close proximity to the point plotted here as this does, it seems to me to be strongly begging for the point of accuracy to criticise a very minute variation when this is a summation of component parts.

Q. Maybe you can just answer one simple question and eliminate all of this. You could have drawn a line which

would have shown lease reserves and would have more nearly given weight to 1937, 1938 and 1939 than the line you drew? That is a fact, isn't it, without any qualification?

A. It would have been possible in the manner that you mentioned, but this is still a summation and I would like to—

Q. The summation is more important than any of its *constituant* parts?

A. A summation is a summation of *constituant* parts.

Q. This tells the whole story?

A. Each part is important.

Q. Of course, but you are not going to let a part of your total be given any more importance, certainly, than your total, are you?

A. Do you consider it no point, Mr. Keffer, that the summation comes to a certain figure and that must be a final point on your curve also?

Q. I don't know that I know what you mean. You were drawing to the answer, is that what you mean?

A. When this curve was drawn an answer was there and we had the answer.

Q. You drew to the answer regardless of where the curve ought to have been?

A. The degree of difference you refer to as the microscopic degree, Mr. Keffer.

Q. I think it would figure out quite a little bit of the time. I see that you ran it across the page twice.

A. This is the way it was drawn. The summation of other equitably drawn curves constitutes a fourth point on this; however, this wasn't drawn entirely with respect to it, yet it was drawn through it and you can—

Q. I don't desire all that explanation. I just desire one thing and that is, that it is contrary to the statement you made yesterday that you could take those three points and give each of them greater weight than you are giving them here and draw a line that would show more reserves than you stated yesterday.

A. I don't think there would be any more or a particularly better line than shown here.

Q. I am not talking about the best line or the worst line. I am talking about giving consideration to the point there, which is the whole basis of the question.

A. You haven't given consideration to the fourth known point on the curve at all.

Q. Have you? What is the fourth point—the answer out here (indicating)?

A. That is one of them.

Q. Of course, I am assuming that you are working to the answer rather than assuming you are working from the answer.

A. You already have the answer—you have the answer when this curve was drawn.

Q. You told me that yesterday, that you drew to the answer, so since you had to draw to the answer your points might have been six inches below there and you wouldn't have considered any of them because you had to get your answer?

A. You had to get your answer?

Q. Yes.

A. Your answer is already here.

Q. Let's take these circles here. Suppose 1935 and 1936 and 1937 were lower and 1939 was up about where it was; 1938 was two or three points higher than where it is, you would have drawn your line precisely where it is drawn now?

A. If it had a different set of data, the answer would have been different and the—

Q. But you are drawing your answer out here?

A. The situation isn't comparable, Mr. Keffer.

Mr. Keffer: Mr. Examiner, I have done my very best to finish this long before now. There are a number of things that were opened up again on redirect that I feel should be gone into. It seems a question or two on them, if the witness will answer them, will dispose of that situation in fifteen minutes. I don't know, but I have quite a few of them noted here.

I hesitate when matters are opened up again to let them stand there as the final words or the thing to be considered when maybe they are contrary to practically everything said before that. That is the thing that makes an examination of this kind to me the most difficult thing I can conceive. I have been trying to rush through here and get this examination completed before 12:30 and I haven't done it. I am sorry that is the situation, too. However, I would like

a few more minutes this afternoon to see if I can't finish the examination.

The Trial Examiner: I want to be considerate under the circumstances, Mr. Keffer, but I would like to get through with Mr. Stevens if at all possible before we recess for the lunch hour.

Mr. Keffer: I will try to do it.

Q. We decided yesterday after some rather lengthy cross examination that if the ratio of production as you have found for Canadian River is not changed that your dotted line would not be changed by additional wells, didn't we?

A. That was the case, yes, sir.

Q. How's that?

A. That was the case, yes, sir.

Q. That is a correct statement, isn't it?

A. Yes.

Q. It is obviously so?

A. Yes.

Q. Then we also determined yesterday from your past experience and your past curves that the drilling of additional wells didn't change your top curve on Exhibit 182, your summation?

A. If they had no production record reflecting or requiring a change.

Q. All right. We even decided that for the year 1937, 1938 and 1939, even where they did have production records, that additional wells didn't change your line, didn't we?

A. That is right.

Witness further testified on redirect examination (Vol. 64, pp. 9181-9185) as follows:

Q. Mr. Stevens, on recross examination there were a great any questions asked you in regard to a hypothetical case something like the following, and I will draw this hypothetical picture and will ask you some questions in regard to it.

I have right here—let's assume we have here a gas field—that this piece of white paper is a gas field and we drill right here (indicating), and the pressures in that well are

400 pounds. Now, that is the only well we have at 400 pounds. Extending out from that 400-pound well is an area which has, we'll assume, a pressure of 410 pounds. We'll assume, to make the illustration similar to the one given by Mr. Keffer some time ago, that it extends out five miles from that well, around there, and there are not any other wells around there.

Now, we take all the gas out of there to 25 pounds. Say we do it in a shorter period of time, say we do it in ten years; say we take all of the gas out of this well down to 25 pounds, all of the gas you can get out of this well down to 25 pounds.

Would you or could you in doing that over that short period of time drain all the gas out of this area out here (indicating) in the 410 pound belt, with the exception of 35 pounds?

A. If that represented one well in the field—

Q. I am talking about just in this field, this distance of five miles here, so it would be comparatively—well, we won't limit that. It is similar to the Panhandle field, we'll say.

A. You wouldn't drain the entire area, no. You would drain the area to such a degree as would give a pressure of 25 pounds, however, and there is some higher pressure outside, naturally.

Q. If you pulled this well down to 25 pounds, would it take some time for the pressures to build back up over 25 pounds before you could ever drain this area out here?

A. Oh, yes. That is a foregone conclusion because you would have to establish another new pressure condition conducive to a differential.

Q. In other words, to assume that when you took this well down from 400 pounds to 25 pounds you would have to assume to get all of it out that you had in effect all one container without any obstructions at all and the perssures wouldn't have to build up, is that right?

A. Yes, either that or greatly—and I mean greatly extended time. That is where the time facor comes in.

Q. Is that what you meant when you said back there in your testimony that present wells in the quadrants here could drain the whole territory if it took a thousand years to do it?

A. If you wanted to assume a purely hypothetical case, that is sometimes stated, but never taken very seriously. That would be the case perhaps.

Q. Ordinarily do pressures in wells build back up as fast as the gas is withdrawn if they have a large area to drain from—even if they have a large area to drain from?

A. As compared with something else?

Mr. March: Read the question.

(The question referred to was read by the reporter, as set forth above.)

The Witness: Well, that is a function of permeability that would have to be stated and if it were low permeability it would take a longer time, and if extremely high it would take a shorter time. I think it is a relative question and the only answer that can be given to it is that relative answer.

By Mr. March:

Q. Mr. Stevens, if you had a half-dozen wells in the Panhandle field, in the western part of the Panhandle field and that is all the wells you had there and if you waited an indefinite period of time, say a hundred thousand years, would it be possible for you to drain all the gas from the Panhandle field, in the western part?

Mr. Spencer: Is this based on one hundred thousand years?

Mr. March: This is based on hypothetical hundred thousand years.

Mr. Spencer: You are talking about one hundred thousand years, all right.

The Witness: Well, they say that hypothetical condition is sometimes stated as a means of illustration of principle, but of course in any sense of practicality it would be—

By Mr. March:

Q. Isn't it just as sensible to say that you can drain all of the gas from the Panhandle field—from the Canadian River acreage, in any reasonable length of time—

The Trial Examiner: There is no use opening that point up again, Mr. March. It has been gone into and gone into.

Mr. March: All right, sir. One more question.

Q. Mr. Stevens, you have been asked a great deal of questions about the undergfound geology of the Panhandle field and its functioning. I will ask you this question: Whether or not you have made a study, a careful study of the underground geology of the Panhandle field of Texas.

A. Not that kind of a study, no.

Mr. Keffer: What was your answer?

The Witness: No.

Mr. Keffer: No?

The Witness: No.

By Mr. March:

Q. Then you don't know exactly the full particulars in regard to the functioning of permeability, porosity, drainage, pay thickness, in the Panhandle field, do you?

A. As explained several times, I believe I have not evaluated those in any respect except as they may be themselves evaluated by the figures used which were pressure and volume.

Q. Would you feel qualified to testify in regard to the underground geology of the Panhandle field, since you have not made a study of the same carefully?

A. No, I wouldn't, except on only the most casual considerations.

Q. You have just made a study of the production and pressures as reflected here in your exhibit?

A. As far as this exhibit is concerned, that it all which that subject—that subject has been employed only as explained in connection with the exhibit by the use of pressure volume data and not through any evaluations of its general or specific aspects.

Witness further testified on direct examination (Vol. 65, pp. 9486-9504) as follows:

Q. Mr. Stevens, you are the same Mr. Stevens who has testified heretofore?

A. Yes, sir.

Q. I hand you an exhibit entitled "Canadian River Gas Company Availability Study," and ask you if you prepared that?

A. Yes.

Q. Did you prepare that yourself or was it done under your supervision?

A. I prepared it myself.

Q. Is it true and correct to the best of your knowledge and belief?

A. Yes.

The Trial Examiner: Mr. March, do you wish to have this marked for identification?

Mr. March: Yes, as Commission's Exhibit No. —

The Trial Examiner: It will be marked for identification as Exhibit No. 197.

(Exhibit 197, Witness Stevens, marked for identification.)

By Mr. March:

Q. Mr. Stevens, there is a written statement I believe in this exhibit running through from Pages 1 to 9, is there not.

A. Yes.

Q. Will you please proceed to read that statement?

A.

"Canadian River Gas Company
Availability Study

The availability study of wells of the Canadian River Gas Company has been carried out on a dual basis:

1. For 92 wells producing December 31, 1939;
2. For 97 wells existing, connected, or to be connected in 1940 or shortly thereafter. The additional five wells include two old wells not previously connected (Bivins A-22 and Masterson B-5) and three wells drilled in 1940 (Thompson A-3, B-3, and Masterson A-5).

All volume figures are on a 14.65 pound base.

The availability study was first contemplated for the date of December 31, 1939. More recent data in the form of back

pressure curves and data for 1940 are now available, and the dual basis has been adopted. In that part of the study dealing with (1), the availability is determined with respect to 92 wells; and in that part of the study under (2), is shown the availability of the 97 wells which are connected in 1940, or will be connected in that year or soon enough thereafter as to require consideration as an active source of supply.

On the dual basis stated, the availability study will determine:

(a) The amount of capacity available from wells connected, or to be connected at mid-year and end of years 1939 and 1940;

(b) The amount of capacity available from present wells at future dates, at pressures expected to exist at those future dates;

(c) The approximate dates at which additional wells are indicated to be necessary to supply a maximum 24-hour demand.

These objectives are accomplished by calculation, and illustrated graphically by weighted rate of decline curves, which show capacity at any pressure, and decline of capacity with decline in pressure.

The back pressure curves and data for 1940, for individual wells, used in the calculation of weighted rates of decline, were supplied by a representative of the Canadian River Gas Company. These curves and data are the results of the 1940 mid-year tests carried out by the Texas Railroad Commission and the company. The curves and data were stated to be identical with those in the Railroad Commission files. These curves are accepted, at least tentatively, as representing the individual wells' characteristic rate of decline in capacity with decline in pressure. Their construction follows, and accomplishes, basically, the general procedure and results described in Monograph 7, published by the U. S. Bureau of Mines.

From these curves and test data, was determined a weighted average rate of decline representing what might be considered a typical well; also a weighted rate of decline

for total Canadian River wells, under the two bases stated. The method used is one in which pertinent factors of individual wells were given their proper weight in the calculation of points which were plotted as a straight line on log paper. These curves, whether for the average well or total wells, represent the weighted rate of decline of capacity with decline in pressure. An alternative method of obtaining a curve of this general nature is to arithmetically average intercept values read from individual well curves. The error in principle of this arithmetical method is that each well does not contribute in its proper weight to the determination of a correct, or weighted, average. The method employed in this study was designed to properly weight the characteristics of each well into the rate of decline for an average well. The decline obtained in this method is called the weighted average rate of decline, referring to the decline in capacity with decline in pressure.

The general fact suggesting and validating the weighting method is, clearly, that in any combination of diverse elements, the component parts contributing to the correct average rate of decline must be weighted with respect to characteristics that are pertinent in determining that average rate of decline. An arithmetical average, in contrast, does not weigh diverse factors, and therefore, cannot be properly used to represent a mean when those diverse factors are contributory parts.

The wells are grouped by quadrants consistent with the system used in estimation of reserves. However, this was not necessary to the weighting method under which any grouping of diverse values may be used. The weighted curves for the average well and for total wells are the results of the study which are directly used. For this reason, and for the reason that the company has copies of individual well curves, the accompanying charts show only the weighted average rate of decline by quadrants and for the average of all wells, and the decline for the total groups of 92 and 97 wells.

The summary tabluation of quadrant data (Table I) has its columns numbered, and in parenthesis are noted in the columns and operation by which derivation is accomplished.

For this reason, no further discussion is provided, as it is believed that the method and procedure of determining the weighted average rate of decline will be clearly evident on inspection of the tabulation.

At this point we have established the rate of capacity decline with decline in pressure for all wells of the Canadian River Gas Company. This relation is shown by the curves of Chart I.

The remainder of the study deals with the availability changes anticipated for the future, coincident with pressure changes occasioned by yearly withdrawals. With the decline of pressure the existing wells will approach a point in capacity at which additional wells will be necessary to supply the maximum 24-hour demand.

From consideration of Canadian River Gas Company well pressures, it was determined that from 1939 to 1940 the arithmetical average rock pressure decline was 8.6 pounds, from 378 pounds to 369.4 pounds. The assumption of 378 pounds for 1939 is made on the statement of company representative that the build-up of wells, after taking the 1939 pressures, was such as to convince him that the average of 375 pounds of actual readings should be increased to 378 pounds. Using 375 pounds as indicated by Texas Railroad Commission data, the pressure loss between 1939 and 1940 would be 375 pounds to 369.4 pounds, or 5.6 pounds, for the amount of production involved. The choice of pressure loss, between 5.6 pounds and 8.6 pounds is very important, as it is a measure of pressure loss to be expected for future years for the volume of production involved. If the lower loss is taken, it is clear that the number of years to reach a given pressure, or open flow to supply a given load, will be larger than if the greater loss of 8.6 pounds for the 1939-1940 volume is assumed to be correct on the statement of the company. For the purpose of forecasting the decline of availability (Table II), 378 pounds is tentatively assumed to be the pressure for 1939. In so accepting this pressure, it is strongly emphasized that the results, in terms of open flow for future years and the time at which additional wells are indicated to be necessary, should be considered as a minimum and very conservative. That is 8.6# ÷ 5.6# = 1.54

represents approximately the ratio of results to be obtained by using 5.6 pounds and 8.6 pounds for the 1939-1940 pressure loss. Using 5.6 pounds, the period before additional wells are necessary would be approximately 1.54 times that shown on the basis of 8.6 pounds loss for 1939-1940. This should be kept in mind when inspecting Table II, the forecast of availability decline.

Considering the production of 48,240,022 MCF for the year ending July 31, 1940, comparable to the times at which pressures are taken, the assumed pressure loss of 8.6 pounds gives a production of 5.61 billion cubic feet per pound. Dividing this production per pound into the annual anticipated load of 49 billion cubic feet, the indicated annual pressure loss is 8.73 pounds per year, 8.8 pounds being taken for the purpose of calculation of Table II. This pressure loss is for that part of the calculation involving 92 wells. The loss per year for 97 wells would obviously be lower as an increase in active size of reservoir would result in more production per pound less, or less pressure loss for a given volume. The ratio of this loss is assumed to be the ratio of the recoverable reserves for the 92 wells as against 97 wells. This is 96.9 per cent, giving a pressure loss per year for 49 billion cubic feet of 8.5 pounds on 97 wells. This loss is conservative the reasons that the 8.8 pounds' loss was explained to be conservative. The current annual production of Canadian River Gas Company is approximately 46 billion cubic feet. For the purpose of this study, it is assumed to be 49 billion cubic feet yearly, to provide for reasonable increase of load allocable to the Denver line requirements.

Due to the fact that pressures are taken by the Railroad Commission at mid-year and company records are kept for calendar years, it is necessary to convert the mid-year data to the end of calendar year. This was done by considering July 31 to be the mid-year point, and the mid-point over which pressures are taken. The five months to December 31 provides the 5/12 by which pressure drop between mid-year points is multiplied. This gives 374 pounds plus as an average for 92 wells, on the basis of using 378 pounds for mid-year 1939, which is very close to the 375-pounds average mid-year pressure if the Railroad Commission figures are strictly taken. Thus, for practical purposes, the mid-year

test data on basis of 375 pounds can be accepted as representing the end of 1939, on the basis of 378 pounds taken for mid-year 1939 as claimed by the company for reason of build-up. Any difference as small as a pound for the end of 1939 is of no consequence when pressure is converted ultimately to form P_t2 or the pressure factor $P_t2 - P_a2$, as the difference in value in this form represents an indistinguishable difference on the scale of Chart I or Chart II.

Refer to Table II headed "Forecast of Decline of Availability—From Wells Existing and Producing December 31, 1939, and Supplemented by Existing Wells to Be Added in 1940." This tabulation is carried forward on the dual basis, one part for the 92 producing wells of December 31, 1939, and one part involving 97 wells which include two old wells to be connected and three new wells already drilled which are to be connected in 1940 or shortly thereafter.

Columns 1 and 2. These columns require no explanation.

Column 3. This column tabulates the total recoverable reserves at the end of the year, obtained for successive years by subtraction of 49 billion cubic feet per year. That part of the column for 97 wells differs from the figures shown for 92 wells in the amount occasioned by the addition of wells not hitherto considered. Since no production record exists for these wells which could be used as a basis for estimating recoverable reserves or expectancy, they were added on the basis of average of previously existing wells. The reserves figure for end of year 1939 was taken from a previously submitted exhibit entitled "Estimate of Recoverable Gas Reserves, Present Wells."

Column 4. This column tabulates the year and pressures for consecutive years resulting from the yearly pressure losses already described.

Column 5. Anticipated annual production of 49 billion cubic feet, subtractable from the recoverable reserves of 92 wells and 97 wells.

Column 6. Annual pressure loss for 49 billion cubic feet per year, obtained as already described.

The remaining columns tabulate data on a weighted basis derived from the first part of this study.

Columns 7, 8 and 9. The weighted well head pressures for 92 and 97 wells on which availability was calculated correspond to, but are not identical with, the pressures of column 4. Taking the end of year 1939 as an example, which, as explained, is for practical purposes the same as mid-year 1939 using the Railroad Commission data, the weighted formation of pressure P_f is 404.696 pounds. Subtracting the weight of gas, the weighted absolute well head pressure is 380.85 pounds, and the weighted well head gauge is 367.85 pounds. For succeeding years' value, 8.8 pounds yearly loss is consecutively subtracted. From these pressures is then determined the well head gauge, formation pressure, P_f and P_f2, which latter value is found on the weighted curve for 92 wells and the corresponding delivery capacity read on the horizontal scale of Chart I. Similarly, values for 97 wells for columns 8, 9 and 10 are determined.

It will be noted that the weighted well head pressures are about 6 pounds below arithmetical average gauge for 92 wells and about 6 pounds below for 97 wells. This variation in difference for 97 wells results from addition of new wells, which increased the weighted average P_f approximately one pound for the company's wells (Table I).

Column 10. This column is obtained by squaring the P_f values of column 9.

Column 11. This column represents delivery capacity read opposite values of column 10 and from the curves for total wells of Chart I and Chart II.

Column 12. This column is 25 percent of column 11. At this point, another conservative position assumed for this study should be noted. The curves are delivery curves indicating ability to deliver at the surface, and not absolute open flow curves indicating ability to produce a larger amount of gas at the sand face. Capacity in the sense here used refers to capacity to deliver at the surface.

Refer to Chart II on which the group curves of 92 wells and 97 wells of Chart I are repeated, but in a more separated relation for convenience in reading.

These curves, with their notations, are believed to be self-explanatory. On the right is indicated several yearly dates.

Next, reading to left, is indicated corresponding availability at 25 percent of capacity. Next, to left of the curve is the corresponding weighted average well head pressure, and farthest to left is indicated the number of years after 1939. Between the two curves is an auxiliary scale showing, as a matter of convenience, the weighted average well head gauge pressures corresponding to values of the pressure factor scale. To determine further the approximate arithmetical well head gauge pressure from the scale, it is necessary only to add 6 pounds when considering the 92-well curve, and 5 pounds when considering the 97-well curve. Every year was not indicated on the curves to avoid confusion. However, they can be identified on the curves by referring to Table II. The purpose of these curves is to indicate when 25 percent of capacity is incapable of supplying a maximum 24-hour delivery rate of 190 MMCF. This volume was adopted after finding that the maximum to 1940 was approximately 180 MMCF.

From inspection of Chart II and Table II, it will be noted that:

(a) For the 92 wells of December 31, 1939, 25 percent of delivery capacity does not decline to 190 MMCF or lower until after the close of 1957, or 18 years after 1939.

(b) For the 97 wells of December 31, 1940, 25 percent of delivery capacity does not decline to 190 MMCF or lower until after the close of 1959, or 20 years after 1939.

At this point it is again emphasized that assumption of pressure data as recommended by a company representative, as against pressures published by the Texas Railroad Commission, results in a more rapid pressure loss, open flow loss, and availability loss for a given volume of gas removed, and that acceptance of the 378-pound average for 1939 claimed by the company is an extremely conservative position to adopt in this study. Adoption of the 375-pound average for mid-year 1939 would give results which would be 1.54 times those under (a) and (b), that is 27 years for 92-well basis and 30 years for the 97-well basis, before additional wells would be necessary to supply a maximum 24-hour demand of 190 MMCF for the total Canadian River system.

The analysis of back pressure data for the dual basis of 92 and 97 wells of Canadian River Gas Company, as described, summarizes to the following conclusions:

For Weighted Average Rate of Decline of Weighted Average Well

	Basis	
	92 Wells	97 Wells
1. Weighted Average Capacity, 1939, MMCF	17.837	—
Weighted Average Capacity, 1940, MMCF	17.394	17.888
2. Weighted Average Closed-in Formation Pressure P_f, 1939 (Abs.)	404.696#	—
Weighted Average Closed-in Formation Pressure P_f, 1940 (Abs.)	399.040	400.265#
3. Weighted Average Closed-in Pressure at Well head, 1939, Gauge	367.85	—
Weighted Average Closed-in Pressure at Well Head, 1940, Gauge	362.53	363.68
4. Arithmetical Average Closed-in Pressure at Well Head, 1939	375.05	—
Arithmetical Average Closed-in Pressure at Well Head, 1940	368.3	369.4
5. Q value at 10 M Pressure Factor, 1939 and 1940, MMCF	2.339	2.375
Q value at 100 M Pressure Factor, 1939 and 1940, MMCF	12.440	12.693
6. "N" value or slope, 1939	.7256583	—
"N" value, or slope, 1940	.7256583	.7278999
7. Pressure Factor, 1939	163.779	—
Pressure Factor, 1940	159.233	160.210

	Basis 92 Wells	97 Wells
For Weighted Rate of Decline—Total Well Curves		
8. Total Open Flow, 1939, MMCF	1,671.90	—
Total Open Flow, 1940, MMCF	1,625.36	1,672.48
9. "Q" Value at 10 M Pressure Factor, MMCF, 1939 and 1940	218.93	234.00
10. "Q" Value at 100 M Pressure Factor, MMCF, 1939 and 1940	1,164.25	1,250.65

The weighted average and total group curves can be plotted from the above data, which can be identified on table and chart Nos. I and II made part of this exhibit. The curves are calculated from mid-year back pressure data for 1940. The 1939 pressures as reported by the Texas Railroad Commission were used to determine capacity on the 1940 curves. The pressures noted in these conclusions and on Table II should not be confused with the adjusted pressures used for end of 1939 and 1940 as explained in the section dealing with decline of availability.

11. At various future dates the wells will be capable of supplying maximum 24-hour demands as follows: (From Table II)

End Year	Years After 1939	Availability @ 25% Capacity 1 MMCF 92 Wells	97 Wells
1942	3	375.0	405.0
1947	8	307.5	337.5
1950	11	270.0	295.0
1955	15	213.75	237.5
1957	18	191.25	218.75
1959	20	168.75	192.5

12. For the 92 wells of December 31, 1939, 25 percent of delivery capacity does not reach a required maximum 24-hour delivery rate of 190 MMCF until after the close of 1957, or 18 years from 1939. From the standpoint of capacity, no additional wells are necessary until that time.

13. For the 97 wells to be connected in 1940 or shortly thereafter, 25 per cent of their delivery capacity does not

reach a maximum 24-hour delivery rate of 190 MMCF until after the close of 1959, or 20 years from 1939. From the standpoint of capacity of wells active in 1940 or shortly thereafter, no additional wells will be necessary for 20 years.

Attention is again called to the fact that this study is conservative by reason of pressure considerations previously explained, and that the interval before wells are necessary from the standpoint of capacity may be greater than stated by approximately one-half.

In working out this availability study to the point where it could be determined when additional wells were necessary, the calculations necessarily arrive at a definite year. The conclusion as to definite years is, in degree of importance considered secondary to the fact that that year is beyond what might be considered as a reasonable period of time. That is to say, the results of this study would still be entirely valid had the availability been so reduced as to indicate wells to be necessary at some earlier date but still beyond a reasonable period of time.

The tabulations and charts constituting part of this exhibit are listed below

Table I. Summary—Analysis of Back Pressure Data—Construction of Weighted Average Rate of Decline.

Chart I. Weighted Average Rate of Decline Curves, by quadrants and for average of 92 wells, weighted decline of capacity with decline in pressure for total of 92 wells and 97 wells. This chart is illustrative of the data and calculations of Table I.

Table II. Forecast of Decline of Availability.

Chart II. Weighted Decline of capacity with decline in pressure, for total of 92 wells and 97 wells involved in the dual basis of the study. On these curves are indicated various periods of time, to the point where the wells concerned will reduce in capacity so that 25 percent of that capacity will not supply a maximum 24-hour rate of 190 MMCF. The curves of this chart are illustrative of the data of Table II.

The Trial Examiner: Do you have another question of Mr. Stevens, Mr. March?

Mr. March: Yes.

Q. Mr. Stevens, you stated I believe here that the back pressure curves and data for 1940 for individual wells used in the calculation of weighted rates of decline, were supplied by a representative of the Canadian River Gas Company?

A. Yes.

Q. What do you mean by that?

A. As to the representative, Mr. Watson supplied those curves and they constitute Exhibit 97, I believe, and by the curves themselves, I mean that those were stated by Mr. Watson to be identical with similar curves in the office of the Texas Railroad Commission and were curves built up from data taken in company—or under supervision—in company with or under supervision of both the Canadian River Gas Company and the Texas Railroad Commission.

In short they are the 1940 back pressure tests and curves taken by the Railroad Commission and the Canadian River Gas Company.

Q. And in so far as individual wells are concerned you just adopted those curves of the company?

A: I have, yes.

Q. All of which are found in Exhibit 97?

A. Yes.

Mr. March: That's all.

Cross Examination

By Mr. Spencer:

Q. Mr. Stevens, what do your working papers consist of in connection with this exhibit?

A. They consist of rather extensive calculations, Mr. Spencer, which are summarized there.

Q. And I assume your working papers will be available to our representatives for checking?

A. As far as I am concerned, with the concurrence of counsel.

Mr. Spencer: Does counsel have any objection to that?

The Trial Examiner: Mr. Stevens' working papers I presume will be made available?

Mr. March: They will. They will be made available. When do you want them?

Mr. Spencer: Not right at this moment. That is all for the present. I wish to reserve cross examination on this exhibit.

The witness further testified with respect to pressure drop on Canadian River wells as related to production, which is tabulated as follows: (Vol. 86, pp. 12953-12954.)

Year	Production for Each Pound Lost in Pressure
1937-1940	11.13 billion cubic feet
1938-1940	8.156 " " "
1939-1940	6.619 " " "

The witness further testified on redirect examination (Vol. 86, pp. 12953-12963) as follows:

By Mr. March:

Q. You have stated several times here in answer to questions, Mr. Stevens, that you were conservative here. Now, I will ask you why a pressure drop of 8.8 pounds a year is conservative. Can you illustrate just how it is conservative?

A. Yes. Considering the Canadian River production on three different bases; first, the last four years including 1937, 1938, 1939, 1940, the pressure decline, 16.4 pounds, in those four years from 385.8, to 369.4, an average decline per year of 4.1 pounds for a volume of 37,383,940,000 cubic feet—strike out that relating to 37 billion—the accumulative production comparable to this pressure drop for this period was 182.508 billion. Dividing by the 16.4 pounds pressure drop, we get a figure of 11.13 billion per pound. Reducing all this and following examples to a common basis of 49 billion so that the pressure drop is comparable in all those cases, we divide in this first instance 49 billion by 11.13 billion which gives a pressure drop per year for that period of 4.4 pounds decline.

Speaking of 49 billion, that is comparable with the 8.8 that was used.

Taking the last three years, using 1938, 1939 and 1940—do you want me to read all these figures, or, rather, give the answer? If you want to shorten the record—.

Q. Answer the question the way you see fit. In other words, you better give the figures so that opposing counsel will have an opportunity to see what you have done.

A. The pressure decline in those three years from 386.065 to 369.4, a pressure decline of 16.65, or an average decline per year of 5.555. The volume produced during that time was 135,912,842,000 cubic feet which divided by the pressure drop for the period of 16.665 gives 8.156 billions per pound which in turn divided into 49 billion is 6.008 pounds per year on the 49 billion basis as against the 8.8 pounds used.

Through 1939 and '40, the last example, comprising two years, the pressure drop from 383.37 to 369.40, a difference of 13.97 pounds, corresponding to that was the production of 92,464,196,000 feet, which divided by 13.97 gives a production per pound of 6.619 billion, which in turn divided into 49 billion to obtain the yearly pressure loss on the basis of 49 billion, gives 7.4 pounds per year as compared with the 8.8 used, and that I think illustrates what I meant by conservative, in so far as any other logical grouping undertaken in this kind of study shows a lesser pressure drop than I do assign to Canadian River acreage.

Q. Now, Mr. Stevens, there has been a great deal of discussion here as to what would be the effect upon your study if the production had increased, if your production requirements and the company's requirements were increased considerably in the years to come. Have you made a study of what would be the effect on your study if certain contemplated increases were made or certain increases in production requirements were necessary?

A. Yes.

Q. Now, will you tell me there how long it would be before Canadian River would have to drill any wells? Have you got that figured out? How would the production have to go into that drilling of wells?

A. Basing on 1939 and 1940, the yearly loss in pounds would change if increased rates per year were withdrawn—increased volumes per year, and figuring down to 197 pounds, the point at which the system will fail to supply 190 million cubic feet, I realize that there is a combination both of increase in takes and increase in peak load, predicated for the company, but referring to the most recently stated peak of

190 million—well, I see we are getting into difficulties, because that was claimed to be on a 16.4 pounds' base, but at any rate, to illustrate this, if we take 50 million a year it will be 18.78 years before the present wells would not be able to supply the peak loads.

Q. You mean would be unable to supply it?

A. The time at which it will be unable to supply it, and taking the 52 billion which was outlined, I believe, in Mr. Beardsley's exhibit—59 million exclusive of demands of the line as yet unbuilt to Milwaukee, 52 billion per year, it would be 18.06 years before it will be unable to supply 190 million cubic feet per day.

Q. From what day is that?

A. From the end of 1940.

And going up, with a considerable jump, to 60 billion a year, it will take 15.65 years before 190 million per day cannot be produced by the present wells.

Going up to 70 billion it will be 13.41 years, and going up as an extreme to 80 billion, it will be 11.74 years after 1940, which is in this latter instance certainly more than the seven years of the period from 1940 to 1947.

I realize that this 190 million peak load, if it is 16.4 base, these yearly figures which I have read, to convert that 190 million to 14.65, the periods stated would need to be divided by 1.119, to obtain the answers on the basis of approximately 203 million cubic feet. I don't check that 208, Mr. Keffer. If you are really talking about 190—

Mr. Keffer: I was not talking about 190, Mr. Stevens. It was 186, I believe—yes, 186, on 16.4 base, as your 1940 peak.

The Witness: I beg your pardon. 208 million, that should be revised to, and the previous references to 190 million should be changed to 186 million.

Mr. Keffer: The 190 million was with your 14.65 figure.

The Witness: Yes.

Mr. Keffer: You probably became confused or probably I did.

The Witness: At any rate, that corrects it to the proper basis in terms of your stating 186 million was a 16.4 figure.

Mr. Keffer: That's right.

By Mr. March:

Q. Does that complete your answer, Mr. Stevens?
A. Yes.

Mr. Keffer: May I interject just one question there?

Mr. March: Certainly.

Mr. Keffer: In increasing your volumes which you spoke of, you failed to increase your peaks also, didn't you, Mr. Stevens, in the answer you just gave?

The Witness: As a matter of fact, I think I stated practically an absurdity when I stated 80 billion per year. I have not increased the peaks accordingly. To increase those peaks beyond a certain point of the capacity of the line obviously requires extensions of the pipe line system and they will not, if I understand the situation correctly, increase greatly beyond—or if at all—beyond the present 186 million on the 16.4 base without extensions to the system.

Mr. Keffer: You are talking about the Denver line?

The Witness: No, I am talking about the entire system, including the—that was the peak of the entire system.

Mr. Keffer: That's all.

By Mr. March:

Q. Now, Mr. Stevens, there has been some questions raised here by Mr. Keffer as to whether or not you did not know that the pressure decline per production was accelerating from year to year—Canadian River Gas Company wells. In other words, that the production was going down per pound loss.

Now, I want to know if you had plotted on your Exhibit 182 the 1940 figure, whether that would have shown that the pressure had declined more in 1940 than they did in 1939.

Mr. Spencer: Before you answer, we object to that, Mr. Examiner. If it is going to be evidence, let's have it plotted. Let's see what it is so we can cross examine on it.

Mr. March: You can see what it is, but Mr. Keffer asked the question as to whether or not—time and time again—

whether he didn't know that the pressure declines were accelerating over the years, and I want to find out whether or not in 1940 the pressure decline was greater than in 1939.

Mr. Spencer: Well, I don't object to your doing any of that except this: I don't want you to speculate on what would happen if he had done so. Let's see what it is and get it in the proper form so that we will be able to cross examine on it.

The Trial Examiner: Has he done that, Mr. March?

Mr. March: Yes.

The Trial Examiner: Ask the witness the question.

By Mr. March:

Q. Have you plotted your 1940 figure on your Exhibit 182 curve there?

A. A bit of explanation I think is necessary there in that it must be remembered that in Exhibit 182 the calculated curve on the basis of a ratio was the Canadian River curve. This differs in this respect, that the Canadian River data was used, and the data then so plotted was investigated with respect to the last several years to see what the incline or decline or decrease or increase in the—it was checked with regard to the last few years to determine the changes indicated in the pressure volume or the pressure production trend and that is about the simplest way to describe it.

Q. Does that differ from the factors you used in calculating your curve in Exhibit 182?

A. It varies in this respect, that it is plotted on the Canadian River data alone without any reference to contiguous areas of production.

Mr. March: In view of that fact, Mr. Spencer, I will not ask the question. If I do I will prepare an exhibit on it.

Q. But you can answer this question: Do you know whether or not in 1940 the pressure declines on the Canadian River wells was in excess of 1939?

A. I will answer your question in this way: The 1938, 1939, taken by itself—

Mr. Spencer: Now, just a minute, Mr. Stevens. Let's be careful, Mr. March, because if you get started here you

are going to require a lot more cross examination. You haven't laid any foundation for that particular question.

Mr. March: Oh, yes. The question was asked my witness whether or not he did not know that the decline was accelerating on Canadian River wells. I have a right to ask him a question now as to whether or not he has gotten evidence to show that it was not.

Mr. Keffer: Mr. March, I predicated that on Mr. Watson's figures which was the basis of his exhibit here, and he said on the basis of those figures "yes." In fact, the question has already been answered, favorably, to my mind.

Mr. Spencer: Why don't you save that question?

Mr. March: The question was asked my witness and it is a redirect question. My witness was interrogated on this matter on cross examination.

The Trial Examiner: Read Mr. March's question, will you please, Mr. Reporter?

(The question referred to was read by the reporter as set forth above.)

The Witness: There was not in excess—

Mr. Spencer: Wait a minute. We have made an objection to the question.

The Trial Examiner: Did you make an objection?

Mr. Spencer: Yes. I thought we did. I beg your pardon.

The Trial Examiner: The objection will be overruled.

By Mr. March:

Q. Answer the question, Mr. Stevens. They weren't in excess, you say?

A. They weren't in excess of the production established by 1938 and 1939.

Q. Were they as much?

A. No. I was going to answer that in a graphic sense; that is to say, if you consider the trend established by 1938 and 1939 the curve will have a steeper incline than the curve similarly drawn with respect to 1939 and 1940 and is one of those cases typical of what you might expect over a period of years, where one year may be a little low and

another year a little bit high, and making it necessary to consider them all as a group rather than with respect to consecutive years when you are calculating an amount of gas out per pound or vice versa.

That is due simply to inaccuracies or lack of buildup, any one of which reasons are impossible to determine quantitatively.

Q. So instead of an accelerated decline in 1940 you have a less decline in 1940 than you did in previous years?

Mr. Keffer: He didn't say that.

The Trial Examiner: Just a minute, Mr. March. He didn't say that.

Mr. March: Do you object to me asking that question? You say he didn't say that?

Mr. Keffer: You asked a leading question.

Mr. March: You object to the leading question?

Mr. Keffer: Yes.

Mr. March: Is the objection sustained?

The Trial Examiner: Now, read this question back again, please, Mr. Reporter.

(The question referred to was read by the reporter as set forth above.)

The Trial Examiner: He hasn't said anything like that, Mr. March.

Mr. March: Well, he can state whether he did or not, Mr. Examiner. I understood that he did. I understood that that was the point.

The Trial Examiner: If you understood that, then why ask that question? Do you just want to rehash it?

Mr. March: I want to clinch it.

The Trial Examiner: Well, let the record speak for itself on that.

Watson, witness for Canadian, testified with respect to the arithmetical average pressure of Canadian River wells

and the 1939 and 1940 buildup prior to the taking of the pressures (Vol. 30, pp. 4205-4208) as follows:

Q. You were asked to get the average rock pressure decline for all wells for the past three years. Do you have that information now?

A. Yes, sir.

Q. That is for the years 1938, 1939 and 1940?

A. Yes, sir.

Q. Will you give that, please?

A. Those are numerical rock pressure averages.

Q. You took the number of wells and averaged them?

A. In 1938 the arithmetical average rock pressure was 383.5 pound gauge; 1939, as I have previously testified, the average rock pressure was 375 pounds. That was a test made in mid-year 1939 as recorded and reported on that day. When I made my 1940 rock pressure report I found additional pressures taken after the date of the 1939 report reflected that the 375-pound rock pressure was lower than it should have been since all of the wells had not been shut off for any sufficient length of time. I, therefore, revised the 1939 rock pressure, arithmetical rock pressure, to 378 pounds as observed after the mid-year 1939 report.

Then in 1940 the rock pressures officially observed by the Railroad Commission were 370 pounds.

Q. What was that figure?

A. 370 pounds.

Q. Do you consider that that figure of 378 pounds for 1939 is a more accurate reflection of the pressures obtaining in mid-year 1939 than the one you had previously given?

A. Yes, that is as I have previously explained: If you get the increased pressures after you have made certain observations you have to consider the whole report, and obviously, 375 pounds was too low or I could have never gotten 378 pounds two or three months later.

Q. You attribute it to the fact there had not been sufficient shut-in on some of your wells on the pressures that gave the 375-pound average?

A. That is correct. Several of the wells were not shut in at all and we had no rock pressure on them at the time of the mid-year 1939 report.

Mr. Lange: I wonder if that same thing is true with reference to the 1940 test?

The Witness: No. In the 1940 test the Railroad Commission gave us advance notice that they were going to run the tests. The back pressures must have good rock pressure or they wouldn't work at all, so we had two or three months notice and we worked out a schedule with them as to which well we would test on certain days. By having that schedule we shut off wells in a sufficient length of time ahead of the test to get what we were satisfied was good rock pressure.

Mr. Lange: How long were they shut in for the test?

The Witness: Not less than a week and longer if we could spare the wells. I think it was approximately a week.

By Mr. Keffer:

Q. Right in that connection, Mr. Watson, it may not be clear to someone reading the record who doesn't know the practical operating angle of a gas well: When you produce a gas well at the end of the line, your working pressure on that well is lower than what you refer to generally as the rock pressure, is it not?

A. Certainly. It couldn't deliver gas if it didn't.

Q. If you have a 400-pound rock pressure well after it had been closed in long enough to build up and you started operating that well, its working pressure might be fifty pounds or less than its normal rock pressure, might it not?

A. It must be less than its rock pressure.

Q. Then if you operate that well for a period of time and we go out to that well today while it is in operating condition and close off the line and gauge its rock pressure, you wouldn't get a normal rock pressure?

A. Certainly not.

Q. What would you get? Would it be sub-normal?

A. Most certainly.

Q. Then the practice in taking rock pressures is to shut the wells in for a sufficient length of time that the wells will build up to what might be determined their normal rock pressure, is that correct?

A. Our practice has always been to shut a well in and observe the pressures at intervals of a day or two days or whatever we think is necessary until two consecutive observations have shown no material increase, and when I say "material increase," I mean a tenth of a pound or so, which we are now able to gauge.

STEVENS, Commission Witness, further testified (Vol. 90, pp. 13652-13656) as follows:

Q. Mr. Stevens, I hand you a diagram entitled "Pressure Versus Cumulative Production, Exaggerated Scale, Canadian River Gas Company Wells, Panhandle Gas Field, Texas," and I will ask you to state what that purports to be.
A. That is what it is.

Mr. March: I will ask that it be marked for identification.

The Trial Examiner: It will be marked for identification as Exhibit No. 263.

Mr. Spencer: Exhibit 263, Mr. Examiner?

The Trial Examiner: Yes, Exhibit 263.

By Mr. March:

Q. Mr. Stevens, I notice you have Charts A and B, indicating the same title on each one, is that correct?
A. Yes.

Mr. March: Mr. Examiner, may we have Chart A marked as Exhibit 263-A and Chart B marked as 263-B?

The Trial Examiner: Very well.

(Exhibits 263-A and 263-B, Witness Stevens, marked for identification.)

By Mr. March:

Q. Will you state briefly what these two charts show?
A. The purpose of this exhibit is to show the effect of addition of 1940 data when applied to the pressure-cumulative production data of immediately preceding years of Canadian River Gas Company wells.

Chart A: Chart A is drawn on an exaggerated scale so that the relation of yearly points may be exaggerated and clearly seen.

Curve A, referring to Chart A, of course, is drawn with respect to 1938 and 1939 to show the trend established by those years alone.

Curve B is drawn with respect to 1939 and 1940 to show the trend established by those years alone, and to illustrate

the fact that 1940 data tends to establish the trend of Canadian River wells at a higher level. Curve B also establishes the fact that by reason of its higher position on the chart that the company's wells are not suffering an accelerated rate of decline. Curve B is drawn as indicated with consideration to the average pressure of 97 wells.

The average pressure for these wells is slightly higher than that for 92 wells, this number excluding three new wells drilled in 1940 and 2 old wells which were to be connected in 1940 or soon thereafter.

Curve C is drawn with respect to 1939 and 1940, as was Curve B, but giving consideration to the average pressure of 92 wells. What has been stated in comparing Curve B with Curve A can be said in comparing Curve C with Curve A. The difference in the two comparisons is, one of degree by reason of the lower average pressure of 92 wells already mentioned, and apparent from inspection of Curves B and C relative to Curve A.

Curve D: This curve drawn solid is an average curve drawn with respect to 1938, 1939, and 1940. It does not actually touch the three yearly points. It passes 1938 and 1939 at equal distances and between the two 1940 points; that is, for points represented by the average on 92 wells and on 97 wells, it approximately equals distances from them.

To have drawn the curve near the 92 well point for 1940 would have changed the medial relation with respect to 1938 and 1939. In short, the curve is believed to be properly drawn with respect to all three years. It could with substantial logic be drawn in a closer relation to the 1940 point for 97 wells as that is the number of wells for 1940.

Going to Chart B, the curve on this chart is Curve B of Chart A, using a less exaggerated scale so that the curve may be extended to intersect with an assumed abandonment pressure of 25 pounds, that intersection being at 2895 billions of cubic feet. Subtracting the production to 8-1-40 of 220.5 billions of cubic feet, the reserve recoverable for the 97 wells is 2,374.5 billions of cubic feet.

Further subtracting production of 48.07 billion for the year ending 8-1-40, we arrived at 2326.43 billion as the re-

serves which can be recovered from the present wells as of 8-1-39, using Canadian River wells alone. The figure on the basis of projection of Canadian River data alone is comparable with the recoverable reserve of 2,186.7 billion in Exhibit 182 determined by another method.

It is not the purpose to displace the figure for the reserves to be recovered as shown in Exhibit 182; however, the opportunity is taken to observe that the reserve figure for that exhibit is conservative on the basis of Curve B which was drawn with the effect of 1940 production contained therein.

The essential purpose of this exhibit is to show the effect of 1940 data for company wells. Its effect as indicated by Charts A or B is to influence the pressure-cumulative trend to a higher level. In doing this it is indicated that the company's wells do not have an accelerated decline in pressure.

Stevens also sponsored Exhibits Nos. 263-A and 263-B, which are as follows:

Exhibit No. 263A

CHART A

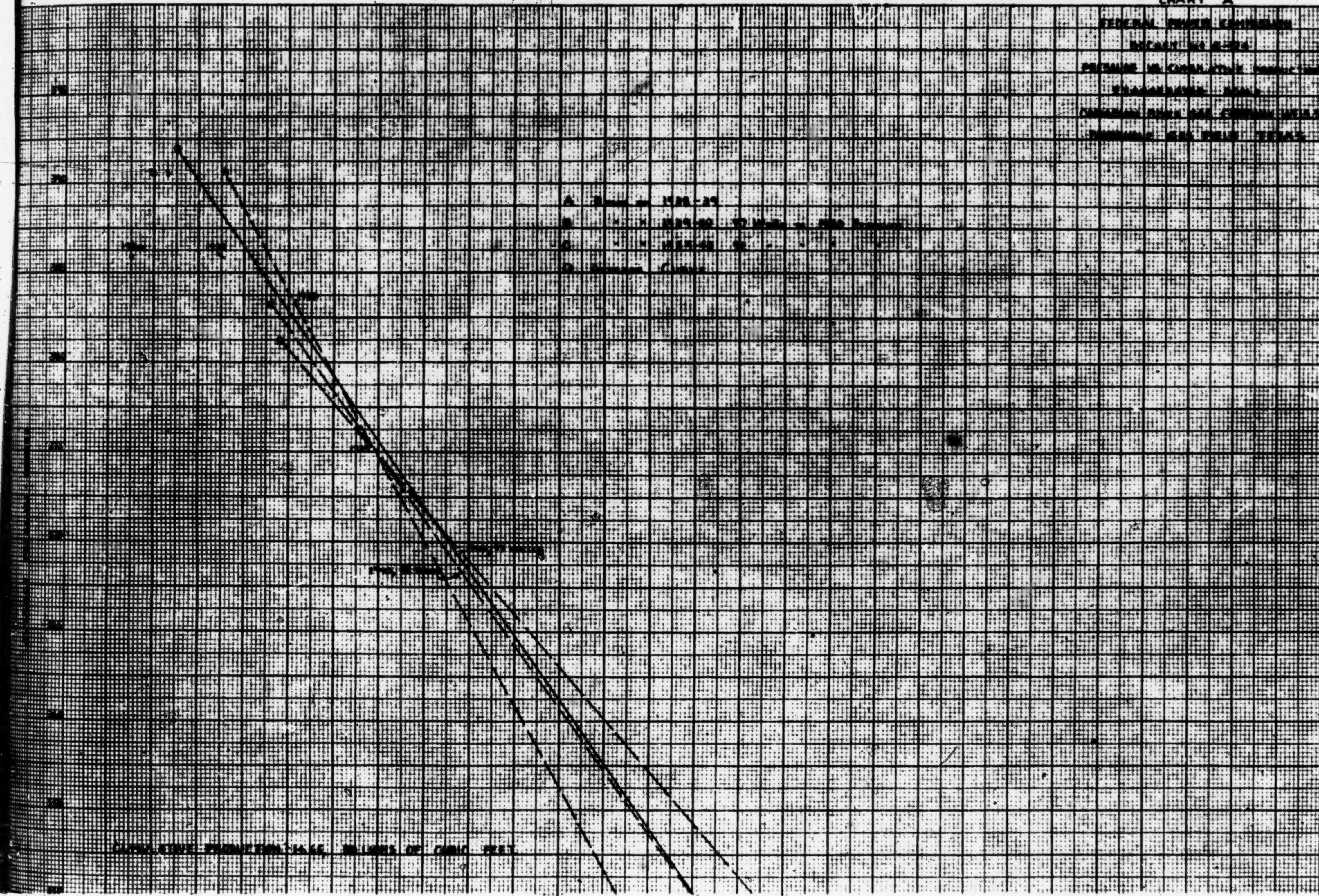
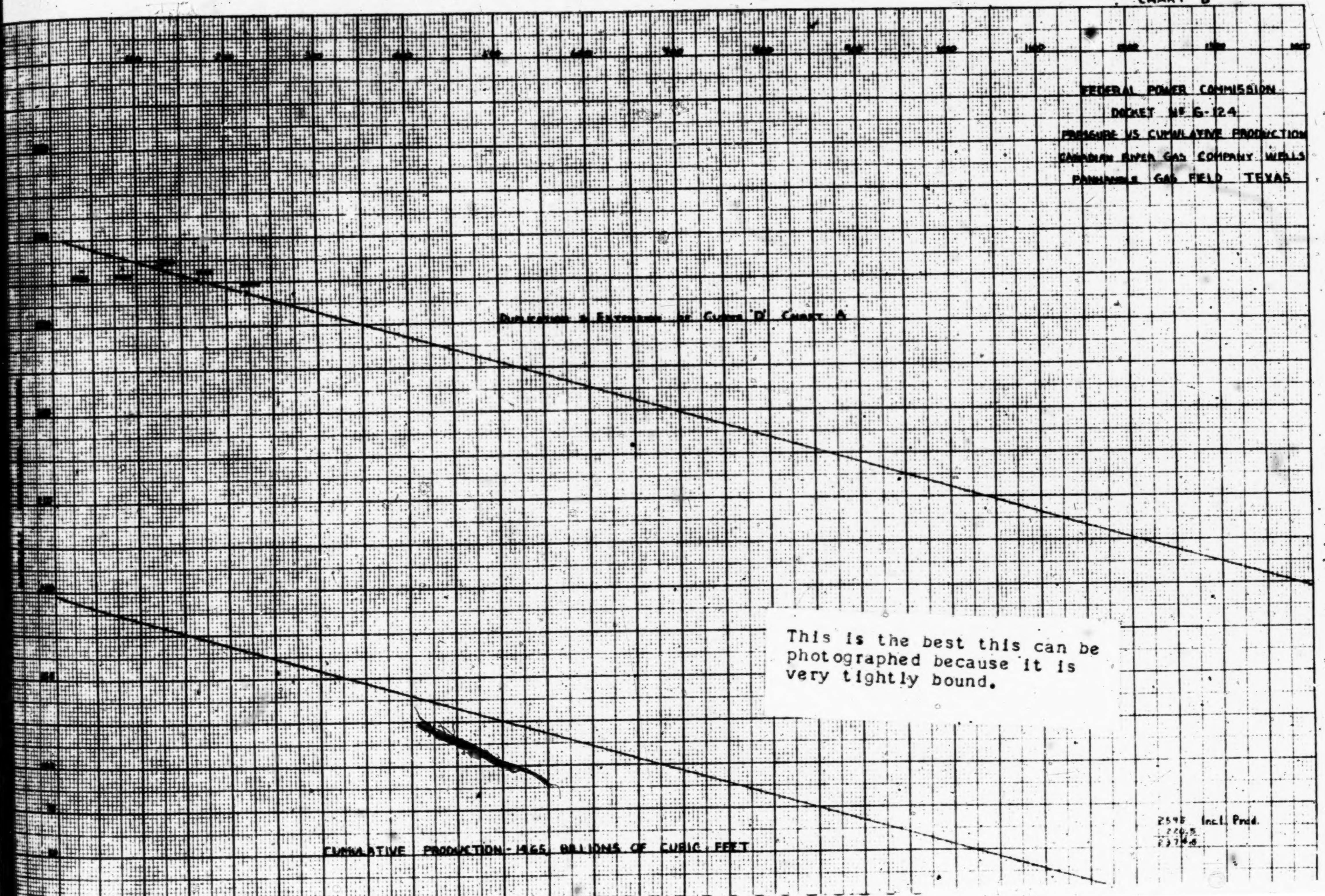


Exhibit No. 263B 4289

CHART B



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Stevens further testified on cross examination (Vol. 95, pp. 14649-14678) as follows:

He stated that he had sponsored Exhibit 182 in which he had used the arithmetical average of certain wells in order to get the estimated producing ability of those wells, and in arriving at that arithmetical pressure average for that exhibit he took into account the wells owned by companies other than Canadian River Gas Company, but all of which were located within the quadrants outlined by Mr. Hammer in which Canadian River had gas acreage, with the exception of Quadrant 3 in Hutchinson County. He took into account only the southwest corner of that quadrant. He took into account many other wells other than the Canadian River wells in arriving at the arithmetical average of pressures for the purpose of determining the volume of gas Canadian River wells would produce.

Stevens also sponsored Exhibit 197, which was an availability study in which he predicted the decline in rock pressure from year to year as to Canadian River Gas Company wells which was also based upon an arithmetical average of the rock pressures of such wells, but in that exhibit he didn't follow the same course he had followed in Exhibit 182, but with respect to Exhibit 197 he took into account only the wells that were actually owned by Canadian River Gas Company.

Witness also sponsored Exhibit 252 which was an availability study but limited to some 55 wells which are furnishing gas to the Denver pipe line, and in that study he considered the arithmetical average rock pressure of those wells only.

Stevens also sponsored Exhibits 263-A and B, which consist of some curves which purport to show the arithmetical average pressure of various Canadian River wells from 1938 to 1940, inclusive. Exhibit 263-B merely projects such curves into the future.

The witness does not recall the type of wells that he included in his arithmetical average in Exhibit 182, but which were not included in Exhibit 263-A and B, 252 or 197. He stated there was no point in knowing that as it wouldn't have made any difference what kind of wells they were.

In constructing arithmetical averages shown on Exhibit 263 the witness indicated the 1939 arithmetical average of Canadian River wells as being 375.05. This was not the same pressure that was used for the year 1939 in the construction of his Exhibit 197.

Watson had previously testified that the arithmetical average pressures of Canadian wells for 1939 was 378 pounds and this was the figure used in Exhibit 197, and when constructing Exhibit 197 he recognized Watson's testimony to this effect. He stated this gave him a more conservative answer with respect to Exhibit 197. He stated, however, that when he came to prepare Exhibit 263-A he felt perfectly justified in using a different figure, 375.05, because this was the Railroad Commission pressure figure. He stated also that Mr. Watson had furnished no proof that the accurate arithmetical average pressure was 378 in 1939. He stated also that he could not raise the 1939 pressure as utilized in Exhibit 263-A and B without also increasing the 1938 and 1940 pressures by 3 pounds, and if he had done so the result would have been just the same in so far as his curves are concerned.

The witness was then asked if it was not obvious that there was no reason why 1940 should be changed. His answer to that was that there was no obvious reason, either, from the Railroad Commission as to why 1939 should be changed.

The witness further testified (Vol. 95, pp. 14660-14667) as follows:

Q. Let's take them one at a time. I have started with 1940. Now, so far as you know, there is no reason on earth to change 1940 up or down, is there?

A. The same is true of 1939.

Q. Can you answer yes to that question? There is no reason?

A. I see no reason at the present time other than indicated. I see no reason at the present time not to take the 1940 pressures as shown by the Railroad Commission for the wells involved in the 1940 point, and I also see no reason why the 1939 should not be considered in the same way.

Q. All right. Now, Mr. Watson—or, the Canadian River

Gas Company does have a different figure for 1939 than the reported Railroad Commission figures?

A. I don't know what they have. I know what they reported to the Commission but other than that I have seen no Canadian River reports.

Q. You have heard Mr. Watson's testimony?

A. He is confident that the buildup should be three pounds higher than recorded by the Railroad Commission.

Q. Didn't he go a little further into that?

A. I don't recall.

Q. Didn't he say a test was made a month later where the well was permitted to build up and showed actually three pounds more?

Mr. March: I object: The record will speak for itself.

Mr. Keffer: He is quoting Mr. Watson here and has predicated his exhibit upon it.

The Witness: I don't remember his testimony as to the month showing three pounds. As I recall his testimony, he was convinced that the 3-pound buildup was necessary but I don't believe he stated any figure other than three pounds.

By Mr. Keffer:

Q. As a matter of fact, Mr. Watson—if he testified there was actually a 3-pound buildup following the time that the Railroad Commission took their pressures, isn't that some proof that the pressures for 1939 were three pounds higher than what the Railroad Commission records showed?

A. To do that, all of the wells would have to be out of service.

Q. Do what?

A. All of the Canadian River wells would have to be out of service.

Q. To do what?

A. To continue the buildup you referred to.

Q. What kind of a buildup did I refer to?

A. What kind did you refer to?

Q. You're telling me. Go ahead.

A. If you have this buildup I referred to, the three pounds, it would be necessary to have the wells out of service in whole or in part.

Q. Is that such an impossible thing in the summertime?

A. Well, it is not an impossible thing, of course.

Q. Do you know how to take rock pressures, Mr. Stevens?

A. Certainly.

Q. How?

A. Is it necessary to explain that?

Q. It ought not to be but isn't it a common practice where they can do so to permit the wells to build up? Isn't that the desired thing?

A. Yes.

Q. Is there any reason on earth why wells can't be shut in ahead of the person gauging the wells so they can build up? In fact, isn't that the ordinary normal and customary way to do it?

A. Yes, a certain number at a time.

Q. Then those wells could have built up three pounds just as Mr. Watson said they did?

A. After the date of the tests, you mean?

Q. Yes.

A. It is possible. There has been no evidence submitted to that effect or any claims made that—

Q. Do you consider Mr. Watson's sworn testimony as evidence in this case?

A. He did not specify individual wells which had built up.

Q. Is it necessary to specify as to individual wells to make the statement that he got a three pound higher average pressure?

A. No.

Q. It is still a fact, isn't it?

A. That probably isn't necessary to be specified. I will take his word for it if he made a dependable statement.

Q. You make the statement here that in 1939 the pressure was 375 pounds. I don't see where you have listed any wells.

A. I can show them to you.

Q. How's that?

A. I have them listed here and I can show them to you.

Q. I am sure you can. I am also sure Mr. Watson could do the same thing, yet you wouldn't want me to disregard your testimony here because you haven't enumerated the wells, would you? Would you?

A. It would be a rather difficult thing—

Q. What's that?

A. It would be a rather impossible to enumerate the wells, Mr. Keffer.

Q. I know it is. The only point is, when you have testified that it was 375 pounds on that particular date that is sufficient to prove that it was 375 pounds, even though you haven't referred to a single well.

Mr. March: I object to the line of questioning. He is arguing a legal point.

The Trial Examiner: I think that is true, Mr. Keffer.

Mr. Keffer: That is perfectly all right. I will withdraw the question; however, Mr. Stevens started the argument.

The Trial Examiner: Perhaps we can go along better if—

Mr. Keffer: I think we can.

Q. As a matter of fact, Mr. Stevens, if the pressures actually were 378 pounds in 1939 instead of 375 pounds, then in the interest of preciseness which you mentioned a while ago, that is the figure you ought to have used?

A. With this provision, that 1938 be also increased and 1940 be also increased in the same amount. As a matter of fact, it isn't definite in a case of the two other years as to how much they should be increased.

Q. All right, let's see. We are increasing 1939 from 375 to 378 because there was an error. There was no error in 1940. Why change 1940 simply because you have corrected 1939?

A. Well, this sureness of error as to 1940 probably isn't described as an error but an inaccuracy. In the case of 1939, if you had a buildup as your sworn testimony indicates, of three pounds—you state that in 1940 there was no discrepancy due to any degree of shut-in. I don't believe that lack of discrepancy of three pounds or any other pounds in the case of 19[illegible] has been established.

Q. As I understand you, then, there would be no reason to change 1940 simply because you corrected 1939, is that correct?

A. I tried to say in so many words that there is no reason that I know of why you should not change 1940 if you changed 1939.

Q. Let's go back all over the thing again. Why are we changing 1939, Mr. Stevens?

A. Under the assumption that this statement of 3 pounds later buildup is an entirely valid one.

Q. All right, there has been no such contention made on the 1940 rock pressures, has there?

A. There hasn't been any that I recall.

Q. Then if we correct 1939 for the reasons you have just stated, there would be no occasion to make any change in 1940, would there, because the same reason doesn't apply?

A. If the reason does not apply in 1940, that would be true, but I haven't seen any substantiation of that point of view.

Q. What point of view?

A. That 1940 was perfect.

Q. You haven't heard anybody question it, have you?

A. Well, the 1939 pressure, as quoted by the Railroad Commission, wasn't questioned and all of the people that have read the pressures in the country and used them, if they have used them, haven't questioned them, either. It is a question of specific disagreement which one of your representatives has claimed to be the case.

Q. Naturally it would be assumed to be correct until it is shown to be to the contrary. I would do that and you would do that.

Mr. March: I object to that. That is a legal conclusion.

Mr. Keffer: There is no such a conclusion to that question, Mr. March.

Mr. March: As a matter of fact, that is merely a legal question. As a matter of fact, Mr. Stevens has already said that—

Mr. Keffer: All right, all right. Mr. March, I'm trying to save time but I might get to a point where I don't care to save time. Let's go on.

Q. What we always want is a correct figure, isn't that true?

A. I believe so, yes.

* * * * *

Stevens further testified (Vol. 95, pp. 14667-14693) with respect to the pressures of certain wells for various years. His testimony, in part, is tabulated as follows:

	1938	1939	1940
Bivins A-21	391	356	386
Killgore A-1	485	384	
Masterson J-1	409	367	396.2
Bivins A-4	385	356	398.6
Bivins A-23	415	343	365
Masterson D-4	388	365	377.5
Masterson F-1	415	413	404.5

The witness stated that he had made some corrections with respect to Killgore A-1 and Masterson F-1 wells due to the fact that a representative of the Railroad Commission had told him that a correction should be made.

The witness then stated that the drop in pressure on Bivins A-21 well from 1938 to 1939 was 35 pounds, and from 1939 to 1940, there was an increase of 30 pounds, and that this indicated quite clearly to him as a gas engineer that there was something wrong with the 1939 pressure, and indicated that the 1939 pressure, in all probability, was taken without an adequate buildup, and that the 1940 pressure was taken with an adequate buildup.

He also referred to the pressure of the Masterson J-1 well and stated that the decline from 1938 to 1939 was 42 pounds and that there was an increase from 1939 to 1940 of 29 pounds, which indicated that there was an improper buildup in 1939 on that well. He referred also to the Bivins A-4 well, and stated that this well had lost 29 pounds in pressure from 1938 to 1939, but had a buildup from 1939 to 1940 of 42 pounds, and that this indicated that something was radically wrong with the 1939 test on that well.

Witness referred also to the Bivins A-23 well, and stated it had a drop in pressure from 1938 to 1939 of 72 pounds, but had increased from 1939 to 1940 22 pounds; that the Masterson D-4 well had decreased 23 pounds from 1938 to 1939, but increased 12 pounds from 1939 to 1940.

The witness was then asked whether, if Mr. Watson had told him there had been an improper buildup for the 1939 pressure survey and had cited as examples some of the wells above-referred to, that would have been sufficient to incline the witness to accept the sworn testimony of Mr. Watson that there had been an improper buildup. The witness an-

swered that he didn't see any particular reason why he should doubt Mr. Watson's veracity or question it.

The witness also stated that the taking of arithmetical averages of wells is not a perfect process, and that where the pressures are averaged arithmetically they may throw you off either up or down depending upon whether the additional wells that are drilled from time to time are drilled in high or low pressure areas, and that as a matter of fact, Exhibit 263-A illustrates this very point. The plat shows the 1940 pressure for 92 wells as being approximately 369 pounds, but when he added the 5 additional wells drilled in 1940 and included these with the others, his average for 1940 was about 370 pounds. He stated that if 5 additional wells were drilled in an area in which the pressures were 400 pounds or above, that this would increase his average pressures for 1940 about 1½ pounds, even though there had not been any production from or drainage into or away from the area.

Stevens further testified (Vol. 95, pp. 14680-14681) as follows:

Q. So you could expect in taking arithmetic averages of wells where you are drilling them from year to year a fluctuation?

A. That is one thing that would cause a fluctuation of point from a straight line, yes.

Q. As a matter of fact, most of the Canadian River's undrilled acreage is in higher than average pressure bands, isn't it?

A. Well, you made quite an example once of this Thompson well, I believe that was.

Q. As Canadian River drills wells from time to time, the drilling of those wells will have a tendency to hold that arithmetical average up to a greater extent than it would have been if they hadn't drilled wells?

A. That is true. You also drilled three new wells in 1939 that would have that effect.

Q. All right.

A. You have three new wells in 1940 which had a parallel effect.

Q. So you can't rely too strongly on arithmetic averages, can you?

A. For what purpose?

Q. For any purpose.
A. Not for meticulous accuracy you cannot.
Q. How's that?
A. Not for meticulous accuracy.

The witness further testified that he did not take the average of all of the wells in the entire quadrant as Mr. Hammer did and as Stevens did in his Exhibit 182 because he wanted to show the conditions on Canadian River's acreage with respect to production versus pressure and exclusive of the contiguous areas.

He stated that in his Exhibit 182 where he considered the additional wells in the various quadrants, the problem was to determine the gas that was going to be produced from Canadian wells alone, and that it was necessary to include contiguous areas because this method involved a ratio and he got this ratio by taking into account all of the other wells. He stated that the same general objective in Exhibit 263-A and B were the same as in Exhibit 182, but that he had simply used a different method. He was then asked that if he was right in Exhibit 182, whether he was wrong in Exhibit 263-A and B, or vice versa, and he answered,

"No, just a simple degree of conservatism."

He stated that if he had taken into account all of the other wells which he did consider in Exhibit 182, he did not know whether the rock pressure would have been less or not because he hadn't made that comparison, but he did say that the rock pressure should be less in that case because, as he recalled it, the wells not considered were in generally lower pressure areas, but he did not know definitely whether all of them without exception were in lower pressure areas than the Canadian wells which he counted or not. He did say, however, that in any event the other wells had no bearing on this Exhibit, and he did not have any concern as to whether they were higher or lower. He said that the wells he did consider were affected by whatever occurred adjacent to them, and in that sense the adjacent areas were to some indeterminate degree incorporated in the study, but that he would make no attempt to evaluate them.

He stated that the effect of the other wells were taken

into account in a different way, but that it was an ultimate conclusion they can never be determined or evaluated.

Witness Stevens further testified (Vol. 96, pp. 14785-14799) as follows:

Q. In Exhibit 182 you have assumed that every time Canadian River drilled a well it increased its available supply of gas by 23 or 24 billion feet?

A. Not specifying the exact area.

Q. I know, but in order to reach that conclusion you had to assume that each well had its own drainage area, didn't you?

A. It is inconceivable to think a well doesn't have some drainage area.

Q. Can you answer my question as to whether or not it had its own drainage area?

A. It had a drainage area unspecified.

Q. Mr. Stevens, on your theory a well that has no production should have no pressure drop, is that right?

A. If it isn't depleted.

Q. If it isn't producing it hasn't started to drain, has it?

A. If it isn't interfered with locally by contiguous areas, that would be the case.

Q. What would you say would be a contiguous area? How far away would a well have to be?

A. That is an indeterminable thing, depending upon physical factors of the formation.

Q. Would you say four or five miles?

A. I wouldn't say any miles.

Q. Do you know where the Masterson B-5 well is?

A. Yes, I do.

Q. The closest well to it is about 2½ miles, is it not?

A. Yes.

Q. And the wells in the other direction will range from four to five miles away, isn't that right?

A. That looks about right.

Q. Would you expect that well to suffer any drop in pressure in the absence of production?

A. It might. As a matter of fact, I believe it did.

Q. Yes, as a matter of fact, it suffered eight pounds drop from 1939 to 1940, didn't it?

A. That is right.

Q. That had to be from a complete buildup in both years, didn't it?

A. Yes, that is right.

Q. There couldn't be any mistake on that pressure in buildup or lack of buildup, could there?

A. I don't think so.

Q. That is because it hadn't produced any gas in that year's buildup. In fact, it hasn't drained any. That is rather conclusive—you do know there was no production from it, don't you?

A. I believe that is the case.

Q. Will you check and see if that is the case?

A. Yes. That is Bivins B-5?

Q. No, Masterson B-5, Quadrant 1, Potter County.

A. I am fairly certain from my recollection, that well isn't connected—it is to be connected and hasn't been.

Q. You don't show any production for it, do you?

A. No.

Q. It is pretty good proof it didn't have any, isn't it?

A. I think so.

Q. That well dropped eight pounds, and eight pounds, strange as it is, is the very average you used on these computations, isn't it?

A. On the average?

Q. On the average.

A. That is right.

Q. So that well is an average well in pressure drop without a cubic foot of production, isn't it?

A. Well, that may be coincidental.

Q. May be what?

A. It may be coincidental. Go ahead.

Q. Will you answer my question?

Mr. March: What is the question?

Mr. Keffer: Read it.

(The question referred to was read by the reporter as set forth above.)

Mr. March: It is obvious the average is the average of the drop.

The Trial Examiner: He hasn't answered it yet. If he would say "yes, that is merely a coincidence," that would have answered the question.

The Witness: That is a coincidental check with the average of 8 pounds.

By Mr. Keffer:

Q. Now, Mr. Stevens, if you would take that well certainly as a test, you could have the 8 pounds pressure drop on Canadian River acreage without a foot of gas, couldn't you?

A. Repeat that question, please.

(The question referred to was read by the reporter as set forth above.)

The Witness: As a test? What kind of a test?. What do you mean by test?

By Mr. Keffer:

Q. As the basis for the comparison.

A. And consequently from that specific well you say that production has no relation to pressure drop, is that what you mean?

Q. You just answer my question. It doesn't matter what I mean. The question is very simple and it is susceptible to a simple answer.

A. It has declined eight pounds without—that is in how many years?

Q. One year.

A. One year?

Q. Yes, that is what you said, wasn't it? If it isn't, check and see if it isn't one year.

A. I don't recall—regardless of what number of years it is, I do not have the pressure for 1939 on this sheet here.

Q. It is 408-400 pounds.

A. All right, I believe I recall that.

Q. How's that?

A. It declined eight pounds in one year without any production.

Q. All right. It is evident Canadian River acreage might suffer an 8-pound drop without any production at all, isn't it?

A. That criterion you apply is unreasonable. It is unreasonable for the reason that while this well has drained eight pounds in one year without production, as you say,

the rest of the wells had some production from them, didn't they? ——

Q. Yes, surely.

A. Well,—

Q. Let's get a little more specific here. The drainage area of that well is determined by drawing a concentric line around it and splitting the difference between it and opposing wells and would be something like 30 or 40 square miles, wouldn't it?

A. Whatever it is makes no difference as the fact is no two wells have to have the same drainage area. The fact that Canadian River took gas out of the surrounding wells, nearby wells, regardless of whatever the distance was—if it went four miles in their case, all right; if it went a mile and a half or two miles to the nearest wells, okay—doesn't mean every well is going to do that.

The reduction of pressure by movement of gas is still a relationship that can't be denied. That gas that went from under the Masterson B-5—we will assume it came out of Canadian River wells—served to increase the amount of production. If you had taken it out of the Masterson B-5 the wells that had gotten it would have shown a lesser amount of gas per pounds, so you end up in this average at the same point. That is the difference?

Q. All right, let's rush along here. It does show unquestionably that the drainage distance of a well in that area is several miles, doesn't it?

A. It indicates that it is at least 2½ miles in that case to the nearest well but that doesn't say anything about the rest of the wells in the field.

Q. You wouldn't assume it would run down one little groove to that one particular well, would you?

A. I am making no assumption as to the character of flow.

Q. And it is especially true when that well 2½ miles away had a pressure that was very little lower than your Masterson B-5 well and the wells to the north and northeast created a differential, you would assume it went to the north and northeast?

A. It doesn't make any difference where it went.

Q. That well does indicate most clearly that all of these

wells owned by other companies within the Canadian River block and those others we named offsetting it have a very distinct bearing and relationship upon the producing life of the Canadian River property?

A. If you base it upon the performance of the B-5 well, that is true, but whatever the effect is—I have repeated it so many times—in the pressure volume record of Canadian River Gas Company it is indicated on Exhibits 263-A and 263-B.

Q. The pressure records for other wells are not in there, are they?

A. No, but the effect is upon the Canadian River.

Q. How do you know?

A. You were claiming they reduced the pressure of the Canadian River.

Q. That is right. Do you agree to that?

A. That is what you are claiming.

Q. Do you agree to that?

Mr. March: In regard to what well?

Mr. Keffer: I am not talking about any particular well.

Mr. March: In regard to what area?

The Trial Examiner: We will stand in recess until 2:00 o'clock.

(Whereupon, at 12:35 o'clock, p. m., a recess was taken until 2:00 o'clock, p. m., of the same day.)

Afternoon Session, 2:00 P. M.

The Trial Examiner: The hearing will be in order.

Whereupon, HARRY F. STEVENS, the witness on the stand at the time of recess, having been previously duly sworn, resumed the stand and testified further as follows:

Mr. Keffer: Mr. Reporter, will you read back the last few questions and answers before we recessed?

(The record referred to was read by the reporter, as set forth above.)

Cross Examination (Continued)

By Mr. Keffer:

Q. Do you agree to that?

A. I think I'd better have the question restated more definitely, if I may.

Q. You had made the statement that I was assuming or evidently assumed or took the position that the other wells we were discussing would affect the Canadian River wells as a result of drainage and I asked you if you agreed to that.

A. Oh, you were referring to contiguous acreage, I believe.

Q. And blocks within our acreage as well, which is not owned by us.

Mr. March: You are asking him now whether or not he thinks those wells are draining your acreage?

Mr. Keffer: Whether those other wells are draining our acreage.

Mr. March: I object to that. This is not a drainage exhibit and has nothing whatsoever to do with it. It is a study of individual wells of the Canadian River Gas Company and the peak performance of those individual wells.

The Trial Examiner: The particular question, though, I believe, Mr. March, is relevant to the exhibits. The objection will be overruled.

The Witness: I don't say that those wells are draining Canadian River acreage or that they do not. I have not made a study of drainage with respect to that. If they are, as stated before, their effect is in the production data of the Canadian River.

Mr. Keffer: I'm sorry, Mr. Stevens, I thought I was listening but I didn't get your answer.

(The answer referred to was read by the reporter, as set forth above.)

By Mr. Keffer:

Q. How is it in the production data?

A. If it is in there it is reflected in the decline of pressure, if that is the case. If they drain to Canadian River, they are reflected in the maintenance of pressure.

Q. Well, then, you would have been on the safe side if you had counted them in in arriving at your arithmetical averages, wouldn't you?

Mr. March: Which exhibit are you talking about?

Mr. Keffer: Where he shows his arithmetical averages, Exhibit 263-A and B, as well as 252. It would apply to both of them as they weren't considered in either one.

The Witness: I don't see as it is necessary. They are already in there.

By Mr. Keffer:

Q. Well, you haven't taken down their pressures and averaged them in with the pressures of Canadian River wells, have you?

A. No, but it is certainly clear that whatever effects that they had affected the Canadian River pressure.

Q. And you assume that whatever that effect is that it is right now fixed and is not going to change?

The Trial Examiner: I think he has answered that, Mr. Keffer.

Mr. Keffer: Yes, I think he has.

Q. All right, now, Mr. Stevens, you stated some time back; that is, this morning, that although your calculations are based upon the assumption that each well on the average would decline the same as every other wells in pressures, yet you knew as a matter of fact that that would not be the case actually. Is that the case?

A. Yes, that the average is the thing that applies. You are assuming in this case here that where we went through wells and showed on the basis of an 8.3, or approximately 8 pounds per year, the working pressure required would be—

Q. As you have stated in your exhibit, Table 3?

A. The gauge working pressure would be more than the rock pressure. You are assuming that they would have to decline that 18.26 pounds in those two years. The meaning of the average year is not that at all. Some of these wells which on your basis you say will decline 18.26 per year, it may well be that that well will decline six pounds or ten pounds or five.

Q. Yes, and it might decline 40 or 50, might it not?

A. Well, that is rather an extreme.

Q. Well, it might decline more than the 18.26, isn't that correct?

A. It isn't very likely.

Q. Well, you have your average at 18.26, you're bound to have some that are more than that, aren't you?

A. That's just the point. Some are more and some less.

Q. And your answer is that they might decline more than 18.6?

A. That's right, and the overall average gives you this margin we referred to.

Q. You do say that is going to vary from year to year according to the actual decline?

A. Depending on how much you take from it.

Q. And then if they are going to vary from year to year, then your average will vary from year to year, necessarily, won't it?

A. No. You are talking about individual wells.

Q. I know, if individual wells aren't going to decline on the average basis, then you have got a different factor each year to figure a different average each year.

A. The average will decline approximately eight pounds on the basis of the record.

Q. I say, I know that is what you say. Now, my point is, if the individual wells will vary from 18.26, then you would have to strike a new average each year to get your correct average, wouldn't you?

A. You still overlook the fact that this 8.8 pounds is that average.

Q. I understand that. That was the average—

A. That doesn't change.

Q. That was the average based upon your pressure figures of 1939 to 1940, wasn't it?

A. 1938, 1939 and 1940.

Q. All right, 1938, 1939 and 1940. All right now, if those individual well performances are going to vary, then as a matter of fact, your average is likely to vary.

A. Not materially, no, if any, on the basis of this record.

Q. How do you know it won't?

A. On the basis—

Q. How do you know it won't? How on earth are you going to tell that your average is going to be the same?

A. On the basis of three years history.

Q. Well, I don't think that answers the question. You say that on the basis of the record of your history it is not going to obtain in the future except on an average?

A. That's the story. That's all there is to it.

Q. Yet you say the decline is not going to be uniform, don't you?

A. It probably won't. It hasn't been, with respect to a given well.

Q. That's right. Well, your average is composed of all of your wells, isn't it?

A. That's right, and it, taking in to consideration those variations, has done so.

Q. Now, if your individual wells will differ, why wouldn't you have to strike a new answer each time?

A. My answer is the same as before.

Q. All right, if you think you have answered it.

On your exhibit 252 you have a type of weighting on that, haven't you?

A. Yes, sir.

Q. You weight your rock pressures with your open flows, don't you?

A. Yes.

Q. All right, then, it all depends on where that variance is going to come, doesn't it?

A. That is taken care of in the method.

Q. Let's see if it is. Now, you have got a weighted average, as you term it, as set out in Exhibit 252 where you have weighted your rock pressure declines or your rock pressures with your open flows. Now, to maintain that average you have got to have the same proportionate decline in the big wells as you have in the little wells, haven't you?

A. The effects of those open flows in terms of their respective curves from which they are read, one from each well, is weighted into that average. That, of course, is one reason why the weighted average isn't the same as the arithmetical average.

Witness Stevens further testified (Vol. 96, pp. 14870-14833) as follows:

Mr. Stevens was referred to his redirect examination with respect to Masterson B-5 well and stated that since that well had been shut in he would think it had a perfect build-up, but he didn't know whether the pressure readings were accurate or not.

Mr. Stevens further testified that the Allison Canadian

River well had a pressure drop of 9 pounds from 1939 to 1940, with a production of 73 million cubic feet, or a pressure drop of 1 pound for each 8 million cubic feet of production, and that the Bivins B-3 well in the same area had a 4 pound pressure drop, with 452 million cubic feet of production, or a production of approximately 113 million cubic feet for each pound lost in pressure.

Thompson A-2 well of Canadian had a production of 269 million cubic feet from 1939 to 1940, with a drop of 11 pounds in pressure, which resulted in about 24 million cubic feet of production for each pound lost in pressure, while the Thompson B-2 well, in the same area, and for the same period, had a pressure drop of 3 pounds, with production in excess of one billion cubic feet, or a production of approximately 360 million cubic feet for each pound lost in pressure.

The Masterson A-1 well for the same period produced 813 million cubic feet of gas, with a pressure drop of 6 pounds, which resulted in a production of 125 million cubic feet for 1 pound lost in pressure, and the Read A-1 well of Canadian in the same area had a production of 125 million cubic feet of gas, with a pressure drop of 12 pounds, or about 10 million cubic feet of production for each pound lost in pressure.

The Bivins A-5 well of Canadian had a production during the same period of 697 million cubic feet of gas, and lost only 1.4 pounds in pressure, while the Seay A-1 well nearby had a production of 104 million cubic feet during the same period with a drop in pressure of 7 pounds, or approximately 15 million cubic feet for each pound lost in pressure, and the ratio in favor of the Bivins well over the Seay well was in excess of 40 to 1.

The witness Stevens further testified (Vol. 96, pp. 14882-14883) as follows:

When you have a pressure decline in a well from one year to another of some 50 or 60 pounds with a certain production, we'll assume for the sake of the question 2 million feet, and the next year that well has a production of one million feet, on the theory that you have been expounding here for the several times that you have been on the witness stand, you would expect a decline in that subsequent

year of half of the decline you got in the preceding year, wouldn't you?

A. We are getting into this average again.

Q. No, I'm not talking about average at all. I'm talking about those wells Mr. March asked you about on redirect when you said or intimated pretty strongly, if you didn't say it, that it was a decline in production that caused those wells to build up.

A. To allow them to build up from their immediately surrounding areas to an indefinite extent. That certainly was a factor in allowing the pressure to build up.

Q. When they were on production with substantial volumes of gas?

A. Certainly. While there may have been substantial volumes of gas, there were greatly reduced volumes of gas.

Q. Are you changing your theory on the relationship between production and drop in pressure?

A. Not on the average.

Q. Just on some wells? Where you want to get a different answer you change?

A. It is simply an explanation of why those wells increased in pressure. It was due to a decelerating rate of production.

Q. Isn't the logical answer that a decelerating rate of production instead of increasing the pressure would simply decelerate the loss of pressure on your theory?

A. Well, it would depend on how bad the heavy production of the previous year pulled it down.

Q. All right, let's drive a peg there and stay right there until I ask you this question: Then in those previous years those wells didn't have a proper buildup, did they, before the pressures were taken?

A. That is illustrated by 1938 and year 1937 points on these curves.

Q. Will you answer my question, please? Those very wells didn't have that proper buildup for taking the 1939 pressures, did they?

A. That would seem to be the case.

Mr. Keffer: All right. That's all. You said that the first time and then you changed it. That's the only reason I went back into it. That's all.

The witness further testified that the pressures shown

on his graph in Exhibit 263-A and B were not weighted pressures. He further stated that if a field is fully developed you can take arithmetical averages and determine production with reference to pressure drops without using a weight medium which brings all of the acreage into account, and in such case an arithmetical average of the pressures of wells will enable one to make an estimate of reserves without any sort of weighting. He stated, however, that the Panhandle field was not fully developed and that the Canadian River acreage was not fully developed. He did state, however, that he could take arithmetical averages as to Canadian River wells and determine the recoverable gas from existing wells, which is all that Exhibit 263-A and B pretends to be.

Referring to the excess of available working pressure over line requirement, the average excess for 1942 and 1947, respectively, is approximately 86 pounds and 44 pounds, and represents the margin of well head working pressure over what is necessary at that point for the conditions of flow of wells totaling 130 MMCF into the lines and with 250 pounds at Bivins station. Having in mind the basic assumption of 250 pounds suction at Bivins, it is indicated that in 1942 and 1947 each well has a margin of both capacity and working pressure. It is also indicated by reason of this excess that 250 pounds suction can be maintained at Bivins station through 1947, that it will not fall to 150 pounds or any point between 150 and 250 pounds before that time. It then follows that no additional compression units are needed before 1947 except as may be dictated by the requirements of 250 pounds suction and the pumping of 130 MMCF.

In 1942 the available suction pressure at Bivins, of 250 pounds, will be 68.55% of the average rock pressure of 364.69 pounds to be expected at that time. In 1947 it represents 77.02% of the average rock pressure of 324.6 pounds expected to exist at that time.

It is my opinion that the foregoing investigation, on the basis of factual data more accurately forecasts the operating conditions than Mr. Rhodes' 'judgment figure' of 150 pounds suction pressure for 1943 and his conclusion as to

the necessity of additonal compressor capacity which is incidental to that judgment figure.

Also Mr. Rhodes' claim that suction pressures of one third or one half or one quarter of average closed in well pressures, said to exist in his experience in other fields, is not applicable to the Panhandle field when investigated with respect to Panhandle wells and company facilities which determine operating pressures.

The witness Stevens further testified (Vol. 96, pp. 14855-14861) as follows:

By Mr. March:

Q. Mr. Stevens, turn to your Exhibit 263-A and B.
A. Yes.
Q. I refer you to your 1940 point there.
A. Yes.
Q. Do you recall yesterday there was some effort to cite you several wells in which pressures had been increased in an effort to cast some doubt upon the accuracy of the 1940 point?
A. Yes.
Q. There were several of those wells mentioned and I believe you stated at the time that those pressures possibly increased because there might have been something wrong with the measurements. Did you during last evening examine the production of those wells in an effort to arrive at some answer as to why the pressure increased?
A. Yes, I have.
Q. I refer you first to the Bivins A-21 which was mentioned. Will you give me the 1939 pressure?
A. 356.
Q. Will you give me the 1939 production?
A. 385.7.

Mr. Keffer: Over what period?

Mr. March: I asked him to give me the 1939 production.

Mr. Keffer: I know that but we have calendar years and mid-years. I want to know which one it is.

The Witness: These are mid-year endings.

By Mr. March:

Q. I will ask you to give me the production of that well in 1939.

A. It was 2,326,909,000.

Q. That much what?

A. Cubic feet.

Q. Now give me the 1940 pressure.

A. That was 385.7, as stated.

Q. Which was an increase over 1939?

A. Yes.

Q. Give me the 1940 production from that well.

A. It was a production which was approximately half of the previous year, 1,361,611,000 cubic feet.

Q. Now let's take the next well. The next well was the Bivins A-14, was it not?

A. Yes.

Q. The 1939 pressure on that well was what?

A. 405.

Q. The production on the well in 1939?

A. 2,658,205,000.

Q. The pressure on the well in 1940?

A. That was 100.5 pounds.

Q. And the production in 1940?

A. That was 1,618,706,000 cubic feet.

Q. The next well is the Killgore A-1. Give me the 1939 pressure on that well.

A. 384.

Q. The production?

A. 1,024,778,000.

Q. The pressure?

A. 372.7 for 1940.

Q. And the production in 1940?

A. 1,024,326,000 which is almost exactly the same as the previous year.

Q. During that period the pressures did decline for that well?

A. They did decline. That was the one about which the area was discussed.

Q. Let's take the Masterson F-1. Will you give me the 1939 rock pressure on that well?

A. 413.

Q. And the production in 1939?

A. 128,772,000.

Q. The pressure in 1940?

A. 445 pounds.

Q. And the production in 1940?

A. 94,504,000.

Q. The next one was the Bivins A-23. Will you give me the pressure for it in 1939?

A. 343.

Q. And the production?

A. 324,170,000.

Q. And the pressure in 1940?

A. 365.2.

Q. The production in 1940?

A. 202,226,000.

Q. In other words, the production in that year was less than half of what it was in the previous year 1939?

A. That is right.

Q. Let's take the Masterson D-4 which was mentioned by Mr. Keffer. What was the pressure in 1939?

A. 365 pounds.

Q. The production in 1939 was what?

A. 3,094,794,000.

Q. The pressure in 1940?

A. 377.5.

Q. And the production in 1940?

A. 1,700,736,000.

Q. Roughly in percentage what was the decline in production in 1940 over 1939?

A. Not quite half.

Q. Now let's take the Bivins F-1.

A. 350 pounds in 1939; as for the production, 66,845,000.

Q. And in 1940?

A. 346.

Q. Pressure?

A. Yes.

Q. The production in 1940?

A. 532,615,000.

Q. I see. Now, Mr. Stevens, do you know of any other wells whose pressures increased in 1940 in the Canadian River Gas acreage?

A. Aside from those listed yesterday by Mr. Keffer, I did find one here, Bivins A-10, which in 1939 had a pressure of 382 pounds; production, 5,022,000. In 1940 it had a pressure of 390.8 with a production of 6,599,000.

Q. Are there any others that you ran across?

A. There is the Thompson B-1, which in 1939 had a pressure of 362 and a production of 16,887,000; for the following year 1940 it had 364.5 pounds for the production and 32,813,000.

Q. There may be others for all you know?

A. Well, I checked them quite carefully but I might have missed some.

Q. You might have missed some?

A. I doubt it.

Q. After looking at the production from these wells, is it not quite possible that the decrease in withdrawals from those wells might have had something to do with the increase in pressures in those wells in 1940?

A. That seems the case. I believe in every case that we have noted—it may not have been in every case, but at least in a majority of the cases the increase in pressure was accompanied by a rather strong reduced proportion of production. The amount of volume isn't the final criterion involved because one well might be able to produce larger amounts than another, whether or not the same pressure drop, but in general those lists represent cases where build-up was observed with greatly reduced rates of production.

Q. Now, Mr. Stevens, if it should be the case that all of those wells Mr. Keffer read off where the pressures are increased, the reason they showed an increase was because of erroneous gauging of the well or taking of the pressure, and is it not equally likely that the Masterson B-5 well where the pressure decreases and there wasn't any production, that might have been an error? In other words, one is—

A. Where there is an error—of course, it would be hard to determine that.

Q. You haven't made a study to find out whether it is an error or not, have you?

A. No, naturally, I don't see how I could check whether the Railroad Commission made an error in their figures or not.

Q. However, you have checked here in two years where there were errors in the mimeographed copy?

A. In one year, 1939.

Q. And two wells.

A. Those were called to my attention. In a sense, I didn't—they were checked after being brought to my atten-

tion. I don't know whether you would call it my checking it as the Railroad Commission checked it.

Q. And the officials of the Railroad Commission told you those two figures for those two wells you discussed this morning were wrong?

A. Yes, and Mr. Peterson adopted the same corrections.

Testimony of C. J. Peterson

Witness for Canadian.

C. J. Peterson, witness for Canadian, testified to various matters relating to gas reserves. His testimony in this connection (Vol. 68, pp. 9924-9944) is as follows:

A. "My name is C. J. Peterson. I was born in 1885 in the Hawaiian Islands and am a resident of Amarillo, Texas.

"I received my high school education in the Hawaiian Islands. I received the degree of A. B. in the Department of Geology and Mining at Leland Stanford University in 1910. My studies at Stanford University were entirely geological and engineering as related to mining and were specalized in economic applications of geology. Geological courses embraced both mining geology and petroleum geology.

"Since leaving Stanford University my entire career has been devoted to economic work in the application of geology.

"In 1910 I took a position with Tonopah Mining Company of Nevada as assistant mining engineer. My work with this company was underground surveying, sampling of ore bodies, drafting, estimations of reserves of ore bodies and reports of examinations on mining properties.

"In 1912 I went down to Venezuela as geologist for the New York and Bermudez Company, which was a subsidiary of the Barber Asphalt Company.

"At that time the Barber Asphalt Company and its subsidiaries had concessions of approximately five-sevenths of the whole Venezuela for oil exploration purposes. However they had to make a choice of the best part of that territory within a certain time limit, and my duties in Venezuela consisted, with a number of other geologists, in making surface

geological surveys, which would determine the segregation from the concessions held by the company, of the properties which were of greatest value for oil and gas exploration.

"I stayed in Venezeula about one year and then went back to work again for the Tonopah Mining Company of Nevada. This time the Tonopah Mining Company employed me as an examining mining engineer in exploration work for the company. This mine examination work embraced examinations ~~of mining~~ properties in practically all of the mining states of the Unted States and also in Nicaragua. After my work in Nicaragua I returned to Tonopah and performed the duties of acting chief engineer for the company for a year at Tonopah.

"In 1917 I took a position with the Empire Gas and Fuel Company as petroleum geologist. In this position my work was confined to detailed structural surface geology in the Osage field, Oklahoma. I left this position in 1917 to do geological exploration with a company which eventually was known as the Hamilton Oil Corporation. This company did geological exploration work in several states, and while in its employ I had to make examinations of properties for them in the states of Oklahoma, Texas, Kansas and Kentucky. My work then embraced surface and sub-surface geology, estimates of oil and gas reserves and detailed surface geological structural surveys of properties.

"In 1921 the Hamilton Oil Corporation sold out their properties to what is now the Continental Oil Company and for a year I worked as a consulting geologist in association with Mr. C. L. Severy, in Tulsa, Oklahoma.

"In 1923 I again went to work for the Empire Gas and Fuel Company, this time as a petroleum geologist in the Rocky Mountain Division, with offices at Denver, Colorado. During my work for the Rocky Mountain Division of the Empire Gas and Fuel Company, I had to make surface geological examinations and determinations of the value of properties in the states of Colorado, Utah, New Mexico, Wyoming and California.

"At the end of 1926 I left the Rocky Mountain Division of the Empire and took a position at the offices of the Em-

pire Gas and Fuel Company, Bartlesville, Oklahoma, as geologist in charge of exploration work for the Cities Service Gas Company. My work with this company embraced subsurface geological work, geological work involved in estimating gas reserves, and was largely connected with the analysis and recommendation to the company of gas pipe line projects.

"In other words, when gas was developed in various localities, it was part of my work to report to the company whether or not it would be profitable to build gas pipe lines to those places. This of course involved estimates, estimating what reserves might be available and whether or not these pipe line projects would be economical.

"In the course of my work in this connection, the Cities Service Gas Company built its gas pipe line from the Panhandle field to Wichita, Kansas, and from there to Kansas City, Missouri. This pipe line now furnishes Kansas City with some of its gas. This pipe line was constructed in 1928 and extends from the Cities Service Gas Company compressor station in the outskirts of Pampa in the northwest quarter of Gray County in a northeasterly direction through Roberts and Hemphill Counties, Texas, to Wichita, Kansas. From Wichita, Kansas it goes to Kansas City, Missouri. After a study of conditions in the Panhandle field, I made the geological recommendations for the construction of this pipe line.

"Also in my work for the Cities Service Gas Company, through a study of the geological conditions in certain abandoned gas fields owned by the Cities Service Gas Company, I recommended the storage of gas in these abandoned gas fields. These gas storage projects are now working on a commercial basis. During the summer when the main trunk gas pipe line does not have a peak load, gas is now stored in these abandoned gas fields, near cities being furnished with gas. During the winter when the pipe line has a peak load, this stored gas is available for any emergency.

"In 1930 I left the employ of the Cities Service Gas Company and took a position as Chief Geologist for the Continental Construction Corporation. The Continental Construction Corporation was the predecessor of the Texoma

Natural Gas Company and the Natural Gas Pipeline Company of America. My duties as Chief Geologist for the Continental Construction Corporation were confined to the study of geological and gas production conditions in the Texas Panhandle gas field.

"In July 1931, the Texoma Natural Gas Company opened offices in Amarillo, Texas. I was then and have been since then Chief Geologist for the Texoma Natural Gas Company and in that capacity have been studying geological and production conditions in the Texas Panhandle field continuously up to the present time.

"As Chief Geologist for the Texoma Natural Gas Company I have an organization under my direction which is known as the geological department. In this department is my assistant, Mr. W. F. Brainerd, a graduate geologist. He is a graduate of the Department of Geology of Syracuse University and took his Master of Science degree at that university in 1922. He has been employed in economic geological work for over seventeen years. We work together a great deal of the time on details of the geologic work, the geologic work involved in drilling wells and the gathering of production statistics. He is very experienced in microscopic work in the examination of samples and cuttings of the formations encountered during the drilling of wells, and he has done a great deal of that microscopic work under my direction.

"For this microscopic work we have some of the best microscopic equipment obtainable. This consists of a Spencer microscope with special lenses and special lighting equipment to light the stage. This microscope was made especially for the examination of well cuttings from sedimentary formations. Sedimentary formations are those formations which in the majority of cases contain oil and gas accumulations.

"Also in my department is a draftsman, who keeps our lease, production, rock pressure and geological maps up to date and keeps the map files and does miscellaneous drafting work.

"My stenographer and secretary handles correspondence

and keeps files on geologic data, statistics of production, scouting data and logs of wells.

"In addition we have a man who does some of the work of plotting up graphic well logs and collects, washes, dries and files samples of well cuttings from the wells drilled in the field.

"The cuttings of each well are filed separately so that at the different depths in each well sampled, we can examine the cuttings of the formations encountered and know what they are.

"We examine not only samples of cuttings from the wells drilled by our company but also samples from wells scattered over the field. In this way we determine the places where the formations occur, the structural conditions in the field and the position in the formations where the gas and oil occur.

"We have examined with the microscope well cuttings from over 600 wells in the Panhandle field. In the course of doing this we have examined over 12,830 samples and have on file in our office for reference over 60,000 samples of well cutting from the Panhandle field.

"In the preliminary work in the field we used to take well cuttings from the surface all the way down to the total depths of the wells, because it was necessary to find out exactly what the conditions were in all formations, and we did not wish to overlook any possibilities in the upper formations.

"As a result of our experience in examining the wells located in different portions of the field, we are now able to narrow our examinations to certain portions of the formations in certain parts of the field.

"My duties for Texoma involve choosing the best locations for the drilling of wells; the determination of the points at which casing must be set in wells; the determination of what depth wells shall be drilled; the determination of the relative value, geologically, of acreage owned by Texoma; the determination of what leases shall be drilled or acquired; and the keeping of permanent records of wells

drilled. These are called well logs. A well log is a record kept by the driller of a well. This record shows the formations encountered in the well, the depths at which they are found, the occurrences of oil, gas, or water which are encountered in drilling the well and the depths at which they occur.

"I have personally spent a great deal of time in studying conditions during the drilling of Texoma's wells, especially in getting the thickness of the gas producing formations, and also in getting information of this nature regarding wells all over the field.

"It is a very important matter to Texoma Natural Gas Company to know what amount of gas is being and has been produced from the Texas Panhandle field. For this reason it has been one of my duties to keep abreast of the production of gas in that field and I have done so throughout the period that I have been serving in the Panhandle field as Chief Geologist for Texoma Natural Gas Company.

"Determination of Thickness of Gas Pays in the Texas Panhandle Field

"1. General Discussion.

"By the thickness of pay is meant the total thickness of gas producing portions of the formations which produce gas. Gas in the Panhandle field occures in intermittent porous streaks, with barren rock between them, in the Dolomite, Dolomitic Limestone, and Limestone zones of the Big Lime, and in the Granite Wash when it is productive. These porous pay streaks vary in thickness and the thickness of pays is determined by totaling the thickness of the pay streaks.

"For anybody to correctly interpret and determine the thickness of pays as shown in the records of logs, it is necessary to have had experience in watching the drilling of gas pay section in the field. It is also necessary to know from experience what the procedure of the drillers is when they record the occurrence of the gas in making up their records of the wells. For instance, in the drilling of some of the earliest wells drilled in the field, gauges of the wells

would be taken at certain intervals during the drilling of a well and these gauges would show increases of gas for those intervals; however, the intervals for which the increases of gas were shown did not consist entirely of gas pays. The gauges were not taken at sufficiently frequent intervals to delineate the gas pay streaks or the barren streaks of formation lying between the gas pay streaks.

"Often matters like this can be cleared up by consultation with the drillers of the wells, by reference to the record of the well showing the formations encountered and, especially by reference to the drilling tickets of a well which show the amount of time involved in the drilling of formations.

"For instance, when a well is being drilled through gas pay formations, the formations are drilled at a much faster rate than when the formations do not have gas pay in them. All these matters have been considered by the writer in determining the thickness of gas pays in the Panhandle field.

"Many of the records used are far from being perfect and have been difficult to interpret. To aid in interpreting these records, I have carefully watched the actual drilling of the gas pays in a great many wells and have talked with a great many drillers in the field to find out their method of recording the occurrence of gas on the wells they drilled.

"To obtain information on this matter, I have personally spent a great deal of time studying conditions during the drilling of Texoma's wells. Many times I have gone out to a well and stayed on the derrick floor for periods ranging from 18 hours to 36 hours. In some cases I have been on a derrick floor 72 hours without any sleep so as to get actual information regarding the formations encountered, the way they were encountered in the well, the way that gas was encountered in the well, the actual thickness of the formation containing the gas and how it acted when it was encountered. I have personally, during the drilling of wells, gauged them during their drilling at five-foot intervals to find out just where the gas was and have had assistants of mine working on shifts gauge wells at five-foot intervals during the entire process of drilling in the gas pays.

"In determining the thickness of gas pay during the drilling in at five-foot intervals, the method is to take a gauge of the well when gas is encountered and determine the open flow at that point. Then, after the well has been drilled five feet, it is again gauged to determine the open flow and then, after another five feet has been drilled another gauge is taken and the open flow determined.

"This process is carried on until all the gas producing formations have been drilled. This shows whether or not there is an increase of gas at five-foot intervals during the drilling of the pay. If the open flow taken at the beginning of a five-foot interval is less than the open flow obtained at the end of a five-foot interval, the record shows an increase of gas during the drilling of that five-foot interval and it is considered that that five-foot interval is in gas producing formation. If the open flow taken at the end of a five-foot interval is less than the open flow taken at the beginning of a five-foot interval, then the record shows that there was a decrease of open flow during the drilling of that five-foot interval and it is considered that that five-foot interval did not contain gas producing formation.

"After these records have been compiled, the intervals which show an increase of gas and are considered to contain gas producing formation are added together, giving the total pay thickness of the gas producing formations encountered in the well. Wherever records in this detail were available, this method was used in obtaining the thickness of the gas pays encountered in wells. I have in my office the well records of over 6,000 wells. In determining the gas pay thicknesses in the field, these well records were combed and as many as possible used in different areas of the field to obtain the average thickness of pay in the field. A great many records were so indefinite as regards records of pay thickness that they could not be used. A great many of the records used were far from perfect, but from knowledge of the method used by the drillers in logging well pays and from records which showed the amount of time involved when drilling the formations these records could be interpreted.

"II. Details of Determination of Thickness

"1. Acreage Classification.

"For convenience in estimating the thickness of pay, the writer has divided the acreage of the field into two classifications; viz:

"a. Best Commercial Gas Acreage

"b. Marginal Gas Acreage

"Following this page is a map of the Panhandle field showing the boundaries of the field and sweet and sour gas areas used in the determinations of thickness."

Mr. Keffer: Mr. Peterson, if I may suggest to the Examiner and to the others, it might be well to glance at the map which is on the following page while Mr. Peterson reads the explanation of the map. I think it will mean more if that is done.

The Witness: "The sulphur gas line is slightly different from the present line, but is merely used as being convenient for the segregation of areas. On this map, the best commercial gas area is colored yellow and the marginal gas area is colored gray. The uncolored areas in central Gray County is designated as unproductive acreage by the Railroad Commission of Texas. The uncolored area in southwestern Moore County is believed by the writer to be unproductive on account of a dry hole drilled there.

"The best commercial gas acreage is that in which the average initial virgin open flow is above 5,000 Mcf. per well and comprises the areas which have received the most intensive development and about which the most data can be obtained. In drawing the boundary line of the yellow area, I picked out the best commercial part of the field as closely as possible, but there are some places in this area where there are wells with an initial open flow below 5,000 Mcf. per well. These areas, however, were comparatively small and the small wells were surrounded with wells of larger open flow so that the area as a whole had to be considered as the best commercial gas acreage.

"The marginal gas acreage is on the marginal edges of

the field except in central Gray County, where it comprises a large part of the field. The average initial open flow of this area is less than 5,000 Mcf per well, but the data obtainable about the area is limited on account of the small amount of development done to date in a large part of it. This area contains some wells with an open flow above 5,000 Mcf. per well, but there are very few of these wells and, for this reason, the acreage as a whole cannot be considered in a class with the best commercial gas acreage. This area seems to be an area with small average open flow. The area includes a number of dry holes and uncommercial gas wells.

"2. Determination of Thickness of Pay in Best Commercial Gas Acreage.

"In the case of the best commercial gas acreage, enough data was available so that averages of pay thickness could be determined satisfactorily.

"On the map showing the best commercial gas acreage and the marginal gas acreage will be noted a north-south line extending through the central portion of Gray County which divides the Panhandle field in what is known as the 'West Field' and what is known as the 'East Field.' This is a line which was adopted by the Railroad Commission of Texas for proration purposes. In determining the thickness of pay for the best commercial gas acreage (colored yellow on the map) this area was divided up into 13 smaller areas, the acreage in each of which was carefully determined. These areas were the sweet and sour gas areas of each county in the West Field and in the East Field. The designation of these areas with their corresponding acre content are shown on Table 1 which follows this page.

"For each of the areas mentioned above, the thickness of pay in wells scattered over these areas so that they would be representative were determined and then the average thickness of pay per well in each area was determined. The results of this work are shown in Table 2 which follows Table 1.

"It will be noted that in obtaining these averages, the records of 627 wells were used. The average thickness for each of the designated areas shown in Table 2 having been

determined, this average thickness was multiplied by the number of acres in each respective area, the result being the number of acre feet in each respective area. Then the number of acre feet of the areas involved in the best commercial area were added, the result being the total acre feet in the best commercial gas area. Then the total acre feet in the best commercial gas area was divided by the amount of the total acres in that area, the result being the weighted average thickness per acre in that area. The details of this computation are shown on Table 3 and it will be noted that the weighted average thickness per acre obtained by this method was 70.01 feet. It is considered, then, that 70 feet is a representative figure for the thickness of gas pays in the best commercial gas area of the Panhandle field. This area contains 1,033,970 acres."

Mr. Keffer: Mr. Peterson, as to Table No. 1 and Table No. 2 and Table No. 3, I suggest that you not read those but that the reporter be instructed to copy them in as a part of the testimony.

The Trial Examiner: Very well, Mr. Keffer, the Examiner will instruct the reporter to follow that suggestion.

(At the direction of the Trial Examiner, the following Tables were copied into the record.)

"Table 1

Best Commercial Gas Acreage in Texas Panhandle Oil and Gas Field

County	Sweet Gas	Sour Gas	Total
West Field Gas Acres			
Carson	195,300	13,560	208,860
West Gray	65,445	2,970	68,415
Hartley	800	13,677	14,477
Hutchinson	40,002	99,834	139,836
Moore	260,377	122,538	382,915
Oldham	—	—	—
Potter	107,347	—	107,347
Total West Field	669,271	252,579	921,850
East Field Gas Acres			
East Gray	17,620		17,620
Wheeler	94,500		94,500
Total East Field	112,120		112,120

Best Commercial Gas Acreage—Summary

Total Gas Acres—West Field	921,850
Total Gas Acres—East Field	112,120
Total Gas Acres—Entire Field	1,033,970
Total Sweet Gas Acres	781,391
Total Sour Gas Acres	252,579
Total Field Gas Acres	1,033,970

Table 2

Calculation of Average Thickness of Gas Producing Formation Per Well in Designated Areas of Best Commercial Gas Acreage

County	No. Wells Used*	Total Thickness Producing Formation (Feet)	Average Thickness Producing Formation Per Well
West Field			
Sweet Gas Area:			
Carson	103	8839	85.82
West Gray	77	3800	49.35
Hartley	0		33.50**
Hutchinson	24	1481	61.67
Moore (Except SW Corner)	87	6804	78.21
Moore (SW Corner)	0		33.50**
Potter	16	1475	92.19
Sour Gas Area:			
Carson	36	2037	56.58
West Gray	18	934	51.89
Hartley	2	67	33.50
Hutchinson	87	5481	63.00
Moore (Except SW Corner)	51	3110	60.98
Moore (SW Corner)	0		33.50**
East Field			
East Gray	31	1616	52.13
Wheeler	95	4208	44.29

*Well records were combed for thickness of producing formations. All records with this information were used that would give a representative average. Many records gave no information as to thickness of producing formation and could not, therefore, be used. 627 wells were used in this calculation.

**For the southwest corner of Moore County in the sweet and sour gas areas and the sweet gas area of Hartley County, the same thickness is used as that obtained for the sour gas area of Hartley County, which is contiguous to the southwest corner of Moore County.

Table 3.

Calculation of Weighted Average Thickness of Gas Producing Formation in Best Commercial Gas Area.

County	No. Wells Used	Average Thickness Producing Formation Per Well (Feet)	Gas Acres	Acres x Feet (Acre-Feet)
West Field.				
Sweet Gas Area:				
Carson	103	85.82	195,300	16,760,646.00
West Gray	77	49.35	65,445	3,229,710.75
Hartley	0	33.50	800	26,800.00
Hutchinson	24	61.67	40,002	2,466,923.34
Moore (Except SW Corner)	87	78.21	247,862	19,385,287.02
Moore (SW Corner)	0	33.50	12,515	419,252.50
Potter	16	92.19	107,347	9,896,319.93
Sour Gas Area:				
Carson	36	56.58	13,560	767,224.80
West Gray	18	51.89	2,970	154,113.30
Hartley	2	33.50	13,677	458,179.50
Hutchinson	87	63.00	99,834	6,289,542.00
Moore (Except SW Corner)	51	60.98	121,038	7,380,897.24
Moore (SW Corner)	0	33.50	1,500	50,250.00
East Field.				
Sweet Gas Area:				
East Gray	31	52.13	17,620	918,530.60
Wheeler	95	44.29	94,500	4,185,405.00
Total West and East Fields:			1,033,970	72,389,081.98

Total Field—Weighted Average Thickness

$$\text{Per Acre} = \frac{72{,}389{,}081.98}{1{,}033{,}970} = 70.01 \text{ Feet}$$

70 Feet Used

Peterson further testified as follows:

On cross-examination the witness testified that he used the driller's logs to a certain extent in determining pay thickness. Some of them were sufficiently detailed that he could get all of the information he needed about pay thickness from them, but others were in such condition that he found it advisable to investigate also the drill tickets turned in by the drillers from which the logs were made. (Vol. LXIX, p. 10090.) During the last 10 years the logs have been better than in prior years. (Vol. LXIX, p. 10092.) Some logs are better today than others but all give valuable information. (Vol. LXIX, p. 10093.) Some logs were discarded because of inadequate information. (Vol. LXIX, p. 10094.) Not all of the discarded logs, however, were inaccurate. Some were discarded because the witness tried to get a representative picture of the condition in an area and for that reason he selected wells that would be fairly and evenly spaced over an area. (Vol. LXIX, p. 10095.)

The purpose of dividing the field into areas was in order to get a more or less uniform spacing of the wells in each area to get a truer average. (Vol. LXXII, p. 10449.) He could use closer spacing in one area than in another but by weighting out the thickness as shown in Exhibit 206, a more accurate average was obtained. (LXXII, p. 10450.) He utilized the most reliable data obtainable. (Vol. LXXII, p. 10459.) In selecting the wells used he spaced them in the different areas in order to get a representative picture regardless of productivity. The wells were spaced so as to give a good average. (Vol. LXXII, p. 10469.) It was necessary to divide the fields into sectors so a better average could be obtained—one that was more representative. If he had taken 16 wells in Potter County for example, and then 16 wells in Moore County, it would have been necessary to take the same number of wells in each county over the field regardless of his information and it wouldn't have given an accurate picture. A determination was made for each area. He utilized more wells in one area than in

another if he could get the proper spacing that would justify him in doing so. (Vol. LXXII, p. 10472.)

He does not recall the exact date on which all of the data was assembled, but he has been assembling it over a period of some 10 years and spent a great deal of time assembling data and information in computing the real thickness, all of which is recorded in Exhibit 206. (Vol. LXXII, pp. 10482, 10483.)

The determinations of pay thickness were made some years ago and were not made for the purpose of utilizing them in any litigation. They were made in order to get definite information that was reliable for operating purposes. (Vol. LXXIII, p. 10554.)

Mistakes or differences in the determination of pay thicknesses tend to compensate each other in the final analysis when the averages are assembled. 627 wells were used in all in the determination of the average pay thickness. If there was a total error of as much as 627 feet in all the wells used this would make a difference of only one foot in each well on the average. The thicknesses are also weighted by areas. The average thickness in each area is multiplied by the acreage in each section or area and the product is divided by the total acreage in the entire yellow area, Exhibit 206 (which is over one million acres). This has the effect again of dividing any error that there may be, so that the whole process develops into one which consists of dividing the error if there is an error. Vol. LXXXII, pp. 12240 and 12241.)

The witness also was cross-examined with respect to the determination of his best commercial area (yellow) and marginal area (gray) as shown on the map contained in Exhibit 206, and on redirect examination figures were quoted as to the natural average open flow at 430 pounds virgin pressure for the entire marginal (gray) area as follows:

Carson County, sweet gas area, the average was 2,900,000 cubic feet per well.

Gray County, West Field, sweet gas area, the average was 3,018,000 cubic feet per well, eleven of which wells were dry holes.

Moore County, sweet gas area, had no wells but the nearest well to it was a dry hole.

Potter County, sweet gas area, the average was 4,100,000 cubic feet per well.

Carson County, sour gas area, the average was 4,720,000 cubic feet per well, which included one dry hole.

Gray County, sour gas area, the average was 1,615,000 cubic feet per well.

Hartley County, sour gas area, the average was 3,500,000 cubic feet per well, but there was one well with an open flow of 10,600,000 cubic feet, which in the opinion of the witness, represented a small part of the area.

Hutchinson County, sour gas area, the average was 3,373,000 cubic feet per well, but if three additional dry holes were considered the average would be 2,650,000 cubic feet per well.

Moore County, sour gas area, the average was 3,583,000 cubic feet per well.

Collingsworth County, sweet gas area, the average was 2,038,000 cubic feet per well.

Gray County, east field, sweet gas area, the average was 3,500,000 cubic feet per well.

Wheeler County, sweet gas area, the average was 3,993,000 cubic feet per well. (Vol. LXXXII, pp. 12235-12239.)

Peterson further testified (Vol. 68, pp. 9945-9948) as follows:

The Witness: "Determination of Average Effective Porosity of Gas Producing Formation in Best Commercial Gas Acreage of Panhandle Gas Field, Texas.

"As geologist in charge of exploration work for the Cities Service Gas Company, part of my work consisted of estimating recoverable gas reserves for scattered producing properties in the Midcontinent fields in Oklahoma and Kansas. These estimates were made in order to determine whether or not it would be advisable to purchase properties, or to build gas pipe lines and purchase gas from specific

properties. Many estimates had to be made where there was no production data available for use of the pressure decline method.

"The whole object in estimating recoverable reserves, is to determine what gas can be recovered. The gas that can be recovered depends upon the action of the wells through which the gas is recovered. By this I mean the producing characteristics of the wells. Of course these producing characteristics depend upon the formations producing the gas. Where there is large permeability in formations without large decrease in rock pressure when heavy quantities of gas are withdrawn from the formations, it follows that there is a corresponding porosity in the formations to accomodate the gas. Thus in many fields there is a relationship between open flow and the gas content of the formations. Like conditions of porosity and permeability in the formations are reflected in the behavior of gas in wells, under the same physical conditions.

"When I was making the recoverable gas estimates referred to above, the back pressure method of testing wells for open flow was in the course of being developed and no information of this character regarding wells was available to me. It was always a help to me in making decisions about my recommendations and estimates, to observe in the field, tests made of wells for rock pressure and particularly for open flow and the operation of blowing a well until its open flow was stabilized. I could tell more about the dependence to be placed on recovering gas from those wells by watching them tested, than I could from reading records. For this reason I used to accompany the men who tested wells for the Cities Service Company to the field and observe the test of the wells. In this way I began to correlate my estimates with field conditions and with thickness of pay and open flows, and by figuring back from my results and production records, formed conclusions about the effective porosity of the producing formations.

"As a result, this experience has established a criteria for judgment so that after working in a field, studying the producing formations, determining their thickness, watching well behavior and ability to deliver gas under varying conditions of rock pressure and open flow, I can weight

the different field conditions and arrive at conclusions regarding average effective porosity and gas acre content, which are practical for reliable estimates of gas reserves.

"Since July 1931, I have been working in the Texas Panhandle field, watching the testing and drilling in of gas wells. I have studied the behavior of the gas wells under varied conditions of delivery of gas, at different open flows and rock pressures and have examined thousands of samples of well cuttings. I have studied porous pay cuttings from gas wells as well as from oil wells. I have had access to records of determination of porosity made from cores of the oil producing formations, which are the same formations which produce gas. I have studied the plotted back pressure curves of wells, which curves show the producing characteristics of wells.

"Correlating all this information together with my experience in other gas fields, I have reached the conclusion that the average effective porosity in the best commercial gas acreage of the Texas Panhandle field is 20 per cent. (This is the area colored yellow on the map attached to the exhibit.)

"It is significant that this same porosity of 20 per cent is noted as applicable to this area of the Texas Panhandle field in the following publications in the bulletins of the American Association of Petroleum Geologists:

"'Gas a Big Factor in the Texas Panhandle' by C. Max Bauer.

"Vol. XII, No. 2, pp. 165-176 and 'Geology and Occurrence of Natural Gas in Amarillo District, Texas' by Victor Cotner and H. E. Crum, Vol. XVII, No. 8, pp. 877-906.

The witness stated on cross-examination that porosity and pay thickness determines the volume of gas in place (Vol. LXXIII, p. 10561) and if the porosity is equal in any two cases the more pay thickness you have the more volume you have. (Vol. LXXIII, pp. 10561, 10562.) Open flow is an indication of relative porosity. (Vol. LXXIII, p. 10565.) However, permeability is a factor that determines open flow but you generally have porosity to accommodate the permeability and you can't have permeability without por-

osity. (Vol. LXXIII, p. 10562.) There is a relationship between open flow and porosity although open flow depends partly on permeability and partly on porosity, but it does not depend entirely upon permeability in any manner. (Vol. LXXIII, p. 10564.)

Commission counsel had marked as Exhibit 216 the working paper of the witness which showed certain porosity tests on cores in the Dolomite Zone of the Texas Panhandle Field made by the Phillips Petroleum Company in March, 1940. The cores were from 19 oil wells and cover 1,015 tests and gave an average porosity of 13.08%. (Vol. LXXII, p. 10370.) The range was from zero to 30%. (Vol. LXXII, p. 10372.)

Commission counsel then had marked as Exhibit 217 a working paper of witness which showed certain porosity tests by Stanolind Oil and Gas Company. The average porosity shown on these tests was 13.21%. (Vol. LXXII, p. 10379.) The Stanolind was unwilling to give the witness the details of its tests but did permit him to make an examination of the details and authorized him to utilize the average porosity as shown by such tests. (Vol. LXXII, p. 10380.)

Commission counsel then had marked for identification as Exhibit 218, core analysis tests furnished witness by Shell Petroleum Corporation, covering the Buff Dolomite in the Texas Panhandle Field. The determinations were made on samples taken at one-half foot intervals. (Vol. LXXII, pp. 10431, 10432.) These cores were taken all the way through the pay formation. (Vol. LXXII, p. 10423.) Witness has examined many more porosity determinations which he could not offer in evidence because they were confidential, but they always came out with about the same average porosity in old producing formations. (Vol. LXXII, p. 10425.)

There is a big correspondence between permeability and porosity in the Texas Panhandle Field—with a large permeability you generally have a large porosity. (Vol. LXXII, p. 10434.) It is improper in the determination of this matter to pick out a few samples only. The proper manner in which to determine the question is to take the averages of all of the samples with respect to porosity and permeability determinations (Vol. LXXII, p. 10440.)

Drill cuttings are known all through the oil and gas profession—they are used by hundreds of companies for examination purposes and many people all through the profession examine them for porosity. (Vol. LXXII, pp. 10414, 10415.) A cutting is just a piece of the formation that has been cut by the bit whether it is a rotary cutting or a cable tool cutting (Vol. LXXII, p. 10388), but a cable tool cutting or sample is better and purer than the rotary sample. (Vol. LXXII, p. 10390.) Samples of cuttings are gathered while the well is being drilled. Cuttings are frequently blown out of the well where gas has been encountered and witness follows the practice of putting in a vent line which leads out from the top of the wellhead 100 feet or more from the rig and samples are sometimes collected in this vent line as the well is drilled. Some of the samples are as much as a quarter of an inch in size. (Vol. LXXII, pp. 10410, 11.) He has picked some samples off the derrick floor that were as much as half an inch in diameter and has made a very careful examination of them. (Vol. LXXII, p. 10412.) He can tell by the appearance of the samples and by an examination of them whether they come from pay formation or not and such samples show the porosity of the formation. Witness has examined thousands of samples and bases his opinion upon such examination. (Vol. LXXII, p. 10418.) Samples of well cuttings are examined to show porosity, that is, to determine the relative porosities occurring by comparison with known porosity obtained from oil wells where porosity tests have been made. In this manner witness has been able to determine average porosities. (Vol. LXXII, p. 10420.)

Witness has obtained all of the porosity core determinations that he could and such determinations tended to absolutely corroborate his idea of the average porosity in the Texas Panhandle Field. (Vol. LXXII, pp. 10422, 10423.) He has seen samples of cuttings which have been determined to have a certain porosity and knows how those samples look under a microscope. He can then take other samples and determine whether or not they are more or less porous than the ones in which the porosity has been determined. (Vol. LXXII, p. 10424.)

Permeability as Related to Porosity

The witness testified on cross-examination that wells having a small open flow generally have low permeability and wells having high open flow generally have high permeability. Gas moves rather slowly through an area of low permeability, permeability being the ability of a formation to allow fluids to flow through it or to permeate it. (Vol. LXX, pp. 10243-10245.) Porosity and pay thickness determine the volume of gas in place. (Vol. LXXIII, p. 10561.) High open flows or large wells are an indication of high reserves. Therefore, when you have large permeability and you produce large volumes of gas out of the well, you must have large volumes in the formation in order to produce it. Consequently, you have also a high porosity. There is not a great deal of porosity in the small wells. The open flow of such wells goes down easily and it takes a long time for them to build up, which indicates a tight formation and a small reserve. You can always tell from the open flow of a well whether it is supported by a large reserve or a small one. The witness would certainly consider that a lease which has a 50,000,000 cubic foot well on it is a great deal more promising, and one that has a higher reserve, than a lease with only a 5,000,000 cubic foot open flow well. It is possible in some fields to have a high porosity and a low permeability but experience shows that this is not true in Texas Panhandle Field. Experience in the Texas Panhandle Field shows small open flow wells consistently produce less than large open flow wells. (Vol. LXXI, pp. 10312-10317.)

Porosity and permeability in the Texas Panhandle Field are very closely related. (Vol. LXXII, p. 10434, Vol. LXXIII, p. 10563.)

Dry Holes and Abandoned Wells

Exhibit 210 was prepared by the witness for the purpose of showing the dry holes and abandoned gas wells in the Texas Panhandle Field. Exhibit 210-A contains a list of the dry holes in the Texas Panhandle Field as shown on the map, Exhibit 210. Exhibit 210-A shows the name of the company drilling the well; the well number; the landowner upon whose land the well is drilled; the location of the well; the total depth of the well, and the date the well was com-

pleted, and the quadrant in which each well was located, as shown upon Commission Exhibit 179 by Hammer.

The abandoned wells on Exhibit 210 are marked in a deep red while the dry holes are marked with a black and red circle with the center colored yellow. The outlines of the field as shown on Exhibit 210 are the same as shown on Commission Exhibit 179 by Hammer. The quadrants as outlined on Exhibit 210, were copied from Hammer's Exhibit 179. (Vol. LXIX, pp. 10339, 10340.)

Witness testified on cross-examination that the map, Exhibit 210, shows approximately 104 dry holes, which is a small number for the size of the Texas Panhandle Field, but which are very significant. The purpose of the map is to show that certain areas of the field are absolutely unpredictable from any information obtainable and that those areas are certainly undesirable for drilling purposes or for development. (Vol. LXIX, pp. 10102, 10103.) Dry holes are sometimes drilled right in the middle of what was thought to be a good producing part of the field. This is significant. Texoma drilled a dry hole right in the middle of a highly productive area and you might go in the middle of the Canadian acreage and do the same thing. In the southwest corner of Moore County there is shown on Exhibit 206 a barren spot or dry island colored in white, which indicates that that area is very doubtful territory, but before a dry hole was drilled it looked very good. You can get dry holes in the most productive areas. (Vol. LXIX, pp. 10108, 10109.)

Texoma drilled a dry hole in Section 18, Block 26, E. L. & R. R. Railroad Company survey, Moore County. This dry hole is surrounded by gas wells within a mile and a half of it in most directions. This well was drilled in the center of a number of productive wells. (Vol. LXIX, p. 10110.) The two dry holes above referred to were drilled in an area that would have been considered as structurally high in the midst of productive gas wells. (Vol. LXIX, p. 10118.) It is possible that other dry holes will be drilled under similar circumstances. (Vol. LXIX, p. 10117.)

The abandoned wells shown on Exhibit 210 were taken from the books of the Railroad Commission. Their records

showed these wells formerly produced gas and were then abandoned. (Vol. LXIX, p. 10083.)

Peterson testified on cross-examination that most of the abandoned wells were in low pressure areas and this fact had a lot to do with their abandonment. Most of them were in areas where the pressures had declined to around 200 pounds, or slightly below 200 pounds, rock pressure. A lot of the trouble in those wells was due to water conditions, which in some cases corroded the casing and probably allowed water to enter the gas producing formation. This water condition has caused the salting up of numerous wells and has made it necessary to abandon them. These wells are listed in Exhibit 214. This same situation prevents the pressure from building up. (Vol. LXX, pp. 10188-10193.)

The abandoned wells owned by Texoma Natural Gas Company are shown in Vol. LXX, p. 10207. The pressures at the time of abandonment ranged from 100 pounds to 145 pounds.

At the time the Texoma acquired the wells above referred to, careful tests were made to determine the condition of the well and the condition of the hole. They were all in good operating condition, which means there was no water in the wells, there was no casing trouble, and they were producing dry gas. They were not producing any oil and were not producing any water. The wells were in good dry condition and there wasn't any water coming into the hole from the bottom. (Vol. LXX, pp. 10211, 10212.)

Peterson further testified (Vol. 68, pp. 9948-9959) as follows:

"Gas Produced From Texas Panhandle Field During Its Life From the Beginning to January 1, 1940.

"It is a very important matter for the Texoma Natural Gas Company to know what gas has been and is being produced from the Texas Panhandle Field. For that reason, as Chief Geologist for the company, it has been one of my duties to keep abreast of the production of gas in that field and to ascertain from reliable sources what production has occurred prior to inauguration of activities of the Texoma

Natural Gas Company in the field, in addition to ascertaining the amount of gas currently produced each year.

"In Table 1, shown on the next page, is an estimate of total gas produced from the Texas Panhandle field on a 16.4 pound base for the life of the field to January 1, 1940. Following Table 1, is a graphic representation of the total gas produced for the period mentioned above, showing the production by daily averages for each of the years from the beginning of the field through the year 1939. This graph shows by scale the daily averages by years in millions of cubic feet and the different classifications of the usage of gas are shown by different colors. The following is an account of the method used in obtaining the figures:

A. Basis of Figures

"1. Gas produced prior to 1932

"In Table 1, the gas produced prior to 1932 is the estimate of Victor Cotner, given in the publication 'Geology and Occurrence of Natural Gas in Amarillo District, Texas' by Victor Cotner and H. E. Crum, bulletin of the American Association of Petroleum Geologists, Volume 17, Number 8, August, 1933, Pages 877-906.

"This estimate is believed to be the most reliable obtainable for this period. Mr. Cotner and Mr. Crum had conducted extensive research into the production of gas in the field in its early years. At the time prior to 1932 when they were present in the field, the Railroad Commission did not issue reports on the usage of gas by the gasoline plants. They did issue some reports on the usage of gas by the pipe line companies.

"Mr. Cotner was with the Columbian Carbon Company which company was interested in gasoline production from gasoline plants and through this connection he was in a position to obtain information on the gas which was being used by these plants.

"Mr. Cotner and Mr. Crum in making up their reports on production from the field worked in collaboration with other geologists in the field. This paper, written by Mr. Cotner and Mr. Crum, is accepted by the fraternity of geologists and members of the American Association of Petroleum Geologists as an authoritative document. I

have used the estimates of gas in that paper in testimony before the Federal courts in legal contentions between the Texoma Natural Gas Company and the Railroad Commission of Texas, and the Railroad Commission of Texas has never questioned in any way that record.

"2. Gas Produced Since 1931—Data From Railroad Commission Reports

"The estimates of gas produced since 1931 were made by the writer. The data on gas used by gas pipe lines and on gas used by gasoline plants was obtained from monthly records and reports obtainable at the office of the Railroad Commission of Texas. To prevent duplication and to give a true picture of gas used by gas pipe lines and gasoline plants, these figures have been adjusted by * * *

Mr. Keffer: You can leave out Table No. 1, Mr. Peterson. You need not read that group of figures but I take it the reporter will, nevertheless, copy that into the record as a part of your testimony.

The Trial Examiner: We will have the reporter do that.

(At the direction of the Trial Examiner, the following Table 1 was copied into the record.)

Table I.

Gas Produced From Texas Panhandle Field.
All Figures on 16.4 Lb. Base.

Revised April, 1940.

	Gas Used By Gas Pipe Lines		Gas Used By Gasoline Plants	
	Total M. C. F	Daily Avg. M. C. F.	Total M. C. F.	Daily Avg. M. C. F.
1926 and Earlier	15,725,533	—	34,300,000	—
1927	8,825,598	24,179	263,800,000	722,740
1928	39,978,176	109,230	330,500,000	903,005
1929	84,767,509	232,240	395,110,000	1,082,493
1930	81,175,878	222,400	412,796,000	1,130,948
1931	86,538,708	237,092	346,255,000	948,644
1932	97,087,294	265,266	283,708,708	775,160
1933	109,179,977	299,123	333,838,516	914,626
1934	147,363,215	403,735	564,804,621	1,547,410
1935	156,695,751	429,303	563,734,998	1,544,479
1936	183,804,643	502,198	330,269,607	902,376
1937	210,333,095	576,255	345,298,466	946,023
1938	207,553,695	568,640	318,498,051	872,597
Total	1,429,029,072		4,522,913,967	
1939	222,299,905	609,041	329,653,273	903,160
Total	1,651,328,977		4,852,567,240	

Table I (Continued).

Gas Produced From Texas Panhandle Fields.
All Figures on 16.4 Lb. Base.

Revised April, 1940.

	Casinghead Gas Not Treated (Blown in Air) Total M. C. F.	Daily Avg M. C. F.	Gas Blown in Air & Used Drlg. Wells M. C. F.	Total Gas Produced Total M. C. F.	Avg. Per Day—M. C. F.
1926 and earlier	92,000,000	—	105,400,000	247,425,533	—
1927 ..	144,000,000	394,521	88,600,000	505,225,598	1,384,180
1928 ..	114,000,000	311,475	49,500,000	533,978,176	1,458,957
1929 ..	90,000,000	246,575	55,800,000	625,677,509	1,714,185
1930 ..	70,000,000	191,781	52,600,000	616,571,878	1,689,238
1931 ..	50,000,000	136,986	16,300,000	499,093,708	1,367,380
1932 ..	32,940,000	90,000	4,026,000	417,762,002	1,141,426
1933 ..	25,550,000	70,000	4,380,000	472,948,493	1,295,749
1934 ..	33,800,000	92,603	21,665,125	767,632,961	2,103,104
1935 ..	28,850,000	79,041	26,037,265	775,318,014	2,124,159
1936 ..	15,540,000	42,459	30,066,628	559,680,878	1,529,183
1937 ..	6,205,000	17,000	29,692,496	591,529,057	1,620,628
1938 ..	5,075,000	13,904	12,268,267	543,395,013	1,488,753
Total	707,960,000		496,335,781	7,156,238,820	
1939 ..	7,300,000	20,000	13,026,239	572,279,417	1,567,889
Total	715,260,000		509,362,020	7,728,518,237	

(Note on bottom of Table I.)

Carbon black is made by burning residue gas from gasoline plants. Thus gas used for carbon black is included in the column showing gas used by gasoline plants.

Gas produced 1926-1931 estimated by Victor Cotner—Geology and Occurrence of Natural Gas in Amarillo District, Texas. Bulletin A.A.P.G. Vol. 17, No. 8, August, 1933. P.P. 877-906.

Gas produced 1932-1939—Gas used by pipelines and gasoline plants from records of Railroad Commission of Texas. Balance of data estimated from weekly oil field scout reports, and Railroad Commission Records.

The Witness: I will just repeat the last sentence.

"To prevent duplication and to give a true picture of gas used by gas pipe lines and gasoline plants, these figures have been adjusted by the writer so that they differ a little from the Railroad Commission figures. For instance, in the Railroad Commission reports on gas used by gasoline plants, some residue gas is noted as being used for repressuring. This gas which is considered to go back into the gas field reservoir is subtracted out by the writer from the total gas used. Also, the gasoline plant reports include residue gas used by the Northern Natural Gas Company for gas pipe line consumption. This gas is subtracted by the writer from the totals of gas used by gasoline plants and added to the totals of gas used by gas pipe lines. Carbon black is made by burning residue gas from gasoline plants. Since the residue gas is a part of the gas consumed by gasoline plants, gas used for carbon black is included in the total of gas consumed by gasoline plants. The figures given in this estimate are on a 16.4 pound base. In comparing them with the sources from which they came, it must be remembered that the Railroad Commission figures issued from the beginning of the field through July 1935 were on a 16.4 pound base. Since July 1935, the figures issued by the Railroad Commission are on a 14.65 pound base.

"3. Gas Produced Since 1931—Estimates Not Given In Railroad Commission Reports

"The Texas Railroad Commission keeps no records on casinghead gas not treated (blown in air from oil wells). None of this gas is metered. This item represents gas blown to air from oil wells not connected to gasoline plants. The writer's estimates of this gas are based upon information from scouts in the field, the number of wells unconnected to gasoline plants and information of local conditions.

"Gas blown in air and used drilling wells is not shown in reports of the Railroad Commission. This includes gas used for fuel by oil companies. Some of this gas is metered and so far as records of this metered gas are obtainable they have been used. This fuel does not include gas used for fuel by gas pipe lines which is included under gas used by gas pipe lines. Fuel has been estimated by figuring up the wells completed each year and the well days and fuel

involved for the wells whose fuel has not been included under gas pipe line consumption. Gas blown in air is the gas blown to air during the drilling and testing of gas and oil wells completed each year. This is estimated from the gas encountered in the wells completed each year, taking into consideration the time of drilling through the gas pays and the method of completion.

"4. Gas Withdrawals From the Field During 1939

"In estimating the total gas withdrawals for 1939, the methods just described were employed, except that more metered gas records were available from the Railroad Commission; also, a few more items of gas blown to air had to be taken into account. In 1939, the Texas Railroad Commission for the first time took back pressure tests on all the gas wells in the sour gas area; operators took more back pressure tests; considerable acidization of wells occurred; and it became necessary to do more blowing of wells during operations in order to keep wells in condition for efficient production of gas. These factors were all considered. The total gas produced from the Texas Panhandle gas field during 1939 was estimated as follows on a 16.4 pound pressure base:"

Mr. Keffer: You may admit the table on Page 10, Mr. Peterson, and the reporter will copy it into the record.

The Trial Examiner: We will have the reporter copy in the table entitled "Gas Produced During 1939," on Page 10.

(At the direction of the Trial Examiner, the following table was copied into the record:)

Gas Produced During 1939.

	Total M. C. F.	Daily Avg. M. C. F.
Gas used by gas pipelines	222,299,905	609,041
Gas used by gasoline plants	329,653,273	903,160
Casinghead gas not treated, blown in air	7,300,000	20,000
Gas blown in air and used drilling wells	13,026,239	35,688
Total gas produced	572,279,417	1,567,889

The Witness: "B. Residue Gas Used for Carbon Black

"Carbon black is made by burning residue gas from gasoline plants. Thus, gas used for carbon black is included in the column showing gas used by gasoline plants (see Table 1). On the graph showing total gas produced from the Texas Panhandle oil and gas field by daily averages, the gas used by gasoline plants is colored brown and in this brown colored area the residue gas used for carbon black is hatched in squares. Following is a record by years of the residue gas used for carbon black during the life of the Panhandle field through 1939."

Mr. Keffer: We will have the reporter copy that table entitled "Residue Gas Used for Carbon Black—All Figures on 16.4 Pound Base," into the record.

(At the direction of the Trial Examiner, the following table was copied into the record:)

Residue Gas Used for Carbon Black—All Figures On 16.4 Pound Base.

Year	Total Gas Used M. C. F.	Average Per Day M. C. F.
1926	1,890,000	5,178
1927	11,280,000	30,904
1928	43,020,000	117,541
1929	136,374,000	373,627
1930	168,104,000	460,559
1931	120,387,000	329,827
1932	117,013,546	319,709
1933	140,866,141	385,935
1934	165,627,522	453,774
1935	175,788,287	481,612
1936	199,590,334	545,329
1937	257,633,750	705,846
1938	239,829,793	657,068
1939	260,257,224	713,033
Total Gas Used	2,037,661,597	

The Witness: "Considering the above tabulation of gas used for carbon black, it is noteworthy that the use of gas for this purpose has gradually increased each year during the life of the field except during the years 1931, 1932 and

1938. The usage of gas for carbon black fell off slightly in 1938 when a total amount of 239,829,793 Mcf. was used. However, the usage again increased in 1939 when 260,257,224 Mcf. was used. This is the largest usage of gas for that purpose for any one year during the life of the field. It is probable that this usage will continue to increase in the future.

"C. Total Withdrawals to January 1, 1939 and January 1, 1940.

"Referring to Table I, the total gas produced from the Texas Panhandle field on a 16.4 pound pressure base to January 1, 1939 was 7,156,238,820 Mcf. and the total gas produced to January 1, 1940 was 7,728,518,237 Mcf.

"D. Progress of Gas Consumption in the Texas Panhandle Field

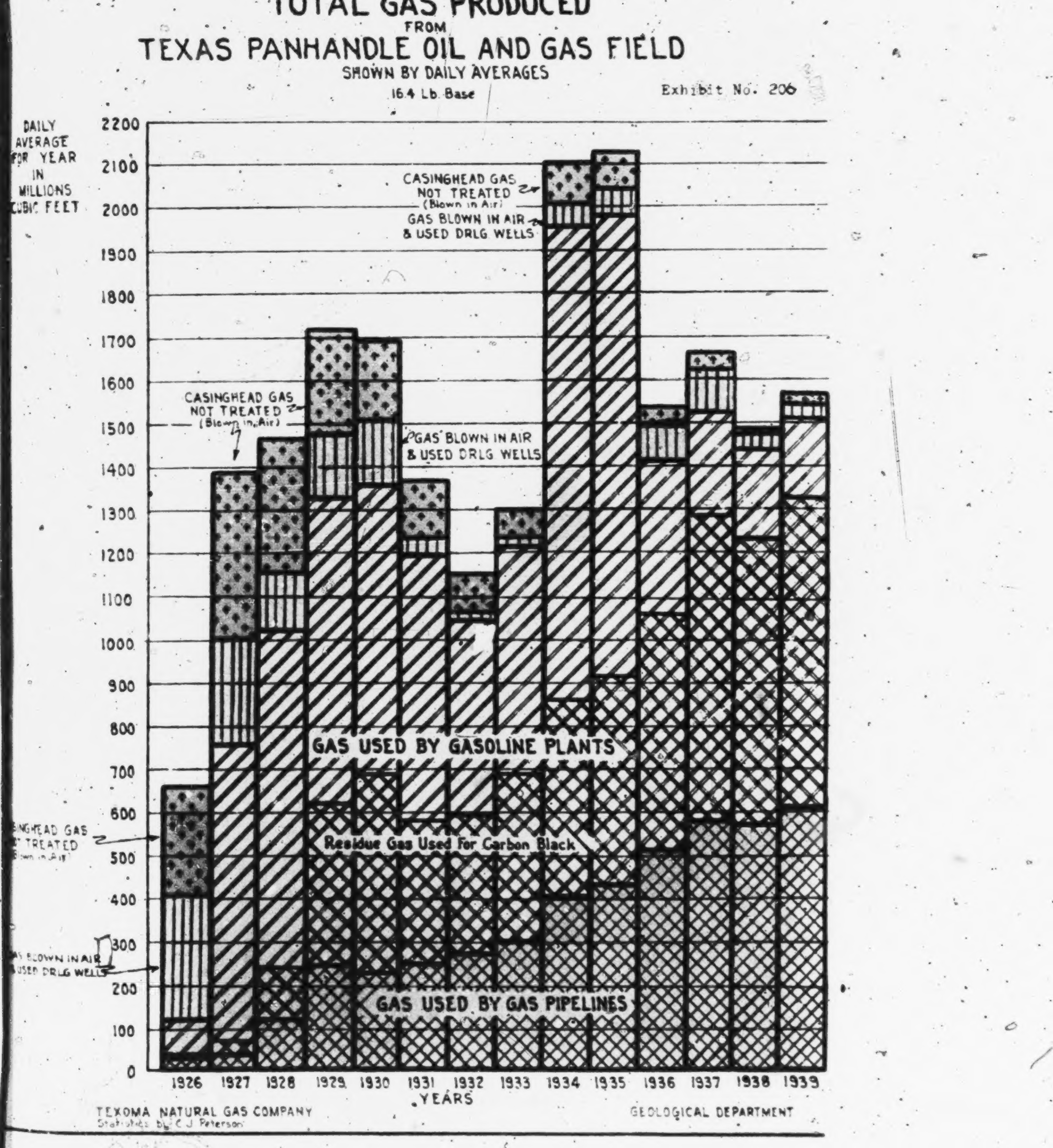
"Referring to Table I and the colored graph illustrating it, it will be noted that except for the years 1930 and 1938 there has been a gradual increase each year in the usage of gas by gas pipe lines. In 1939, they used more gas than in any previous year, viz: 222,299,905 Mcf., which was at a rate of 609,041 Mcf. per day. Since all the gas pipe lines are not yet operating at their full capacity, it is believed that this usage will continue to increase for some time, year by year.

"The amount of gas used by gasoline plants each year has fluctuated considerably. The amount used by these plants increased steadily each year from 1926 through 1930. In 1931 and 1932 this usage of gas fell off somewhat, partly due to enforced regulations against wastage of gas by the Railroad Commission and partly on account of a business depression in the nation. Gas used for this purpose increased considerably above former usage in 1934 and 1935. This was due to the fact that the State of Texas loosened up in their regulation on the usage of gas for gasoline plant consumption during 1933 and 1934 and 1935 gasoline plants were allowed to use dry gas for gasoline and pop residue gas to the air without restriction. In 1936 the State of Texas tightened up its regulations again on the use of residue gas and would not allow the use of dry gas for the production of gasoline where the residue was allowed

to be popped into the air. Gas used for gasoline plants increased from 1936 to 1937 and a decrease occurred in 1938, but again in 1939 there was an increase of this usage of gas over the usage in 1938.

"It seems reasonable to expect that usage of gas in the Panhandle field as a whole will continue to increase each year for some years to come."

Mr. Keffer: If I might just for one moment, I would like to have Mr. Peterson turn back to the graph between Pages 8 and 9, giving us a brief explanation of it.


TOTAL GAS PRODUCED
FROM
TEXAS PANHANDLE OIL AND GAS FIELD
SHOWN BY DAILY AVERAGES
16.4 Lb. Base
Exhibit No. 206
DAILY AVERAGE FOR YEAR IN MILLIONS CUBIC FEET
2200
2100
2000
1900
1800
1700
1600
1500
1400
1300
1200
1100
1000
900
800
700
600
500
400
300
200
100
0
CASINGHEAD GAS NOT TREATED (Blown in Air)
GAS BLOWN IN AIR & USED DRLG WELLS
GAS USED BY GASOLINE PLANTS
Residue Gas Used for Carbon Black
GAS USED BY GAS PIPELINES
1926
1927
1928
1929
1930
1931
1932
1933
1934
1935
1936
1937
1938
1939
YEARS
TEXOMA NATURAL GAS COMPANY
Statistics by C. J. Peterson
GEOLOGICAL DEPARTMENT